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IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION

NOKIA TECHNOLOGIES OY and ALCATEL-LUCENT USA INC., **Plaintiffs,** **v.** **APPLE INC.,** **Defendant.**	**Civil Action No. 2:16-cv-1440** **JURY TRIAL DEMANDED**
APPLE INC., **Counterclaim Plaintiff,** **v.** **NOKIA TECHNOLOGIES OY, NOKIA CORPORATION, and ALCATEL LUCENT USA INC.,** **Counterclaim Defendants.**	

APPLE INC.'S AMENDED ANSWER, DEFENSES, AND COUNTERCLAIMS TO PLAINTIFFS' COMPLAINT

Pursuant to Federal Rules of Civil Procedure 12, 13, and 15, Apple Inc. ("Apple") hereby provides the following amended answer, defenses, and counterclaims in response to the Complaint (Dkt. 1) filed by Nokia Technologies Oy ("Nokia"[1]) and Alcatel-Lucent USA Inc. ("ALU") (collectively, "Plaintiffs") as to all claims and allegations.

NATURE OF ACTION

1. Apple admits that H.264 Advanced Video Coding is a standard promulgated by the International Telecommunication Union ("ITU"), and that certain iPhone, iPad, iPod, Apple

[1] This shorthand includes business or correspondence conducted under the name Nokia Technologies prior to the official incorporation of Nokia Technologies Oy.

Watch, Mac computers, and Apple TV products support H.264. Apple also admits that the Plaintiffs' Patents-in-Suit purport to relate to video coding. Apple denies that it has infringed the Plaintiffs' Patents-in-Suit or benefitted from "Nokia's innovations," or that any asserted patent claim is valid. Apple is without sufficient knowledge or information to form a belief as to the truth of the remaining allegations set forth in Paragraph 1 and, therefore, denies them.

2. Apple admits that it has not entered into a license agreement with Plaintiffs covering patents purportedly essential to the H.264 standard. Apple is without sufficient knowledge or information to form a belief as to the truth of the allegations set forth in the second sentence of Paragraph 2 or to the existence of any purported "established royalty rates" set forth in the third sentence of Paragraph 3, and, therefore, denies them. Apple denies that it has not negotiated in good faith with Plaintiffs and the remaining allegations of Paragraph 2.

PARTIES

3. Apple is without knowledge or information sufficient to form a belief as to the truth of the allegations set forth in Paragraph 3 and, therefore, denies them.

4. Apple is without knowledge or information sufficient to form a belief as to the truth of the allegations set forth in Paragraph 4 and, therefore, denies them.

5. Apple is without knowledge or information sufficient to form a belief as to the truth of the allegations set forth in Paragraph 5 and, therefore, denies them.

6. Apple is without knowledge or information sufficient to form a belief as to the truth of the allegations set forth in Paragraph 6 and, therefore, denies them.

7. Apple admits that it is a California corporation with its principal place of business at 1 Infinite Loop, Cupertino, California 95014. Apple admits that it designs, manufactures, uses, imports into the United States, sells, and/or offers for sale in the United States smartphones, tablets, and other consumer electronics products that support H.264. Apple admits that its

devices are marketed, offered for sale, and/or sold throughout the United States. Apple denies that it has committed any act of infringement of any valid patent.

JURISDICTION AND VENUE

8. The allegations in Paragraph 8 state conclusions of law to which no response is required.

9. Apple denies that venue is proper, pending the U.S. Supreme Court's decision in *TC Heartland LLC v. Kraft Foods Group Brands*, No. 16-341.

10. The allegations of Paragraph 10 state conclusions of law to which no response is required. To the extent that Paragraph 10 contains any allegations of fact, Apple denies them.

PLAINTIFFS' PURPORTED COMPLIANCE WITH RAND

A. The ITU and H.264 Standardization Process.

11. Apple admits the allegations in Paragraph 11.

12. Apple admits the allegations in Paragraph 12.

13. Apple admits the allegations in Paragraph 13.

14. Apple admits that members within ITU-T draft the Recommendations. Apple admits that the H.264 Standard described in the Complaint is described in the H.264 Recommendation. Apple is without knowledge or information sufficient to form a belief as to the truth of the remaining factual allegations set forth in Paragraph 14 and, therefore, denies them.

15. Apple admits that to facilitate the widespread adoption of standards, the ITU must ensure that suppliers of products that support H.264 have access to the standard, and that without access to the standard, product suppliers would be unable to support H.264. Apple also admits that patent holders must have incentives to participate in standard-setting activities. Apple is

without knowledge or information sufficient to form a belief as to the truth of the remaining factual allegations set forth in Paragraph 15 and, therefore, denies them.

16. Apple admits that the ITU has adopted a Common Patent Policy. Apple admits that the quotation in Paragraph 16 is contained in the Common Patent Policy, and states that the Common Patent Policy speaks for itself. Apple is without knowledge or information sufficient to form a belief as to the truth of the factual allegations set forth in Paragraph 16 and, therefore, denies them.

17. Apple admits that the ITU has published Guidelines for compliance with the implementation of the Common Patent Policy. Apple admits that the quotation in Paragraph 17 is contained in the ITU Patent Guidelines, and states that the ITU Patent Guidelines speak for themselves. Apple is without knowledge or information sufficient to form a belief as to the truth of the factual allegations set forth in Paragraph 17 and, therefore, denies them.

18. Apple admits that the quotation in Paragraph 18 is contained in the Common Patent Policy, and states that the Common Patent Policy speaks for itself.

19. Apple states that the ITU Patent Guidelines and the ITU Patent Statement and Licensing Declaration Form speak for themselves. Apple denies the remaining factual allegations set forth in Paragraph 19.

20. Apple states that the H.264 Recommendation speaks for itself. Apple denies the remaining factual allegations set forth in Paragraph 20.

B. Plaintiffs' Purported Compliance with ITU Licensing Obligations

21. Apple admits that Plaintiffs have declared to ITU that they are prepared to grant licenses to certain claims of certain of the Asserted Patents on reasonable and non-discriminatory ("RAND") terms and conditions. Apple denies any implication from the allegations in Paragraph 21 that the Common Patent Policy and/or Plaintiffs' RAND declarations do not apply

equally to claims directed to an encoder. Apple denies that Plaintiffs have fulfilled their obligations under the Common Patent Policy with respect to the Asserted Patents. Apple denies the remaining allegations set forth in Paragraph 21.

22. Apple denies the allegations set forth in Paragraph 22.

23. Apple admits that Plaintiffs have offered to license certain patents to Apple. Apple denies that any such offer was RAND-compliant. Apple denies the remaining allegations set forth in Paragraph 23.

24. Apple denies the allegations set forth in Paragraph 24.

25. Apple admits that Apple and Nokia have been in negotiations for a license to Nokia's patents allegedly essential to the H.264 standard for more than two years, and states that Nokia has never provided Apple any license offer on RAND terms and conditions. Apple admits that it received a letter from Nokia dated August 31, 2014, asserting that Apple infringed patents allegedly essentially to the H.264 standard, and states that Nokia provided no adequate explanation in this letter for its assertion. Apple also admits that in Nokia's letter dated August 31, 2014, Nokia stated that it was prepared to enter into licensing discussions with Apple regarding patents allegedly essential to the H.264 standard. Apple denies the remaining allegations set forth in Paragraph 25.

26. Apple admits that on November 4, 2014, representatives of Apple and Nokia met and Nokia gave a presentation that identified certain parts of the H.264 standard, and then identified patent numbers and claims that Nokia claimed were related to the identified parts of the H.264 standard. Apple also admits that during the meeting on November 4, 2014, Nokia identified a list of Apple products as allegedly infringing. Apple denies the remaining allegation set forth in Paragraph 26.

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[redacted]. Apple denies the remaining allegations set forth in Paragraph 27.

28. Apple is without knowledge or information sufficient to form a belief as to the truth of the factual allegations set forth in Paragraph 28 and, therefore, denies them.

29. [redacted] Apple denies the remaining allegation of Paragraph 29.[2]

30. [redacted] Apple denies the remaining allegations in Paragraph 30.

31. Apple denies the allegations in Paragraph 31.

32. [redacted]

[2] Apple objects to the disclosure or use in this litigation of information that is subject to the parties' non-disclosure agreements (and, specifically, the parties' non-disclosure agreement dated May 12, 2015). Apple's allegations or responses to the allegations shall not be construed as consent to the admissibility or use of such information in violation of the non-disclosure agreements, and Apple reserves all rights with respect to those agreements.

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[redacted] Apple denies the remaining allegations in Paragraph 32.

33. [redacted] Apple denies the remaining allegations in Paragraph 33.

34. [redacted] Apple denies the remaining allegations in Paragraph 34.

35. [redacted] Apple denies that Nokia has negotiated in good faith, and denies the remaining allegations in Paragraph 35.

36. Apple is without knowledge or information sufficient to form a belief as to the truth of the factual allegations set forth in Paragraph 36 and, therefore, denies them.

37. Apple is without knowledge or information sufficient to form a belief as to the truth of the factual allegations set forth in the first sentence in Paragraph 37 and, therefore, denies them. Apple denies the allegations set forth in the second sentence in Paragraph 37.

38. Apple denies the allegations set forth in Paragraph 38.

39. Apple denies the allegations set forth in Paragraph 39.

PUBLIC REDACTED VERSION OF DOCUMENT FILED UNDER SEAL

40. Apple denies the allegations set forth in Paragraph 40.

PLAINTIFFS' PATENTS

41. Apple admits that the U.S. Patent No. 7,532,808 ("the '808 patent") states on its face that it is entitled "Method for Coding Motion in a Video Sequence," and that it issued on May 12, 2009 to Jani Lainema. Apple admits that the Complaint purports to attach a true and correct copy of the '808 patent as Exhibit 3. Apple is without knowledge or information sufficient to form a belief as to the truth of the remaining factual allegations set forth in Paragraph 41 and, therefore, denies them.

42. Apple admits that the U.S. Patent No. 6,950,469 ("the '469 patent") states on its face that it is entitled "Method for Sub-Pixel Value Interpolation," and that it issued on September 27, 2005 to Marta Karczewicz and Antti Olli Hallapuro. Apple admits that the Complaint purports to attach a true and correct copy of the '469 patent as Exhibit 4. Apple is without knowledge or information sufficient to form a belief as to the truth of the remaining factual allegations set forth in Paragraph 42 and, therefore, denies them.

43. Apple admits that the U.S. Patent No. 8,036,273 ("the '273 patent") states on its face that it is entitled "Method for Sub-Pixel Value Interpolation," and that it issued on October 11, 2011 to Marta Karczewicz and Antti Olli Hallapruo. Apple admits that the Complaint purports to attach a true and correct copy of the '273 patent as Exhibit 5. Apple is without knowledge or information sufficient to form a belief as to the truth of the remaining factual allegations set forth in Paragraph 43 and, therefore, denies them.

44. Apple admits that the U.S. Patent No. 8,144,764 ("the '764 patent") states on its face that it is entitled "Video Coding," and that it issued on March 27, 2012 to Miska Hannuksela. Apple admits that the Complaint purports to attach a true and correct copy of the '764 patent as Exhibit 6. Apple is without knowledge or information sufficient to form a belief

as to the truth of the remaining factual allegations set forth in Paragraph 44 and, therefore, denies them.

45. Apple admits that the U.S. Patent No. 6,968,005 ("the '005 patent") states on its face that it is entitled "Video Coding," and that it issued on November 22, 2005 to Miska Hannuksela. Apple admits that the Complaint purports to attach a true and correct copy of the '005 patent as Exhibit 7. Apple is without knowledge or information sufficient to form a belief as to the truth of the remaining factual allegations set forth in Paragraph 45 and, therefore, denies them.

46. Apple admits that the U.S. Patent No. 6,711,211 ("the '211 patent") states on its face that it is entitled "Method for Encoding and Decoding Video Information, a Motion Compensated Video Encoder and a Corresponding Decoder," and that it issued to Jani Lainema. Apple admits that the Complaint purports to attach a true and correct copy of the '211 patent as Exhibit 8. Apple is without knowledge or information sufficient to form a belief as to the truth of the remaining factual allegations set forth in Paragraph 46 and, therefore, denies them.

47. Apple admits that the U.S. Patent No. 6,856,701 ("the '701 patent") states on its face that it is entitled "Method and System for Context-Based Adaptive Binary Arithmetic Coding," and that it issued on February 15, 2005 to Marta Karczewicz and Ragip Kurceren. Apple admits that the Complaint purports to attach a true and correct copy of the '701 patent as Exhibit 9. Apple is without knowledge or information sufficient to form a belief as to the truth of the remaining factual allegations set forth in Paragraph 47 and, therefore, denies them.

48. Apple admits that the U.S. Patent No. 6,680,974 ("the '974 patent") states on its face that it is entitled "Methods and Apparatus For Context Selection of Block Transform Coefficients," and that it issued on January 20, 2004 to Alireza Farid Faryar, Moushumi Sen, and

Kyeong Ho Yang. Apple admits that the Complaint purports to attach a true and correct copy of the ’808 patent as Exhibit 10. Apple is without knowledge or information sufficient to form a belief as to the truth of the remaining factual allegations set forth in Paragraph 48 and, therefore, denies them.

49. Apple admits that Plaintiffs’ have asserted in this Complaint the ’808 patent, ’469 patent, ’273 patent, ’764 patent, ’005 patent, ’211 patent, ’701 patent, and ’974 patent (the “Plaintiffs’ Patents-in-Suit”).

50. Apple is without knowledge or information sufficient to form a belief as to the truth of the factual allegations set forth in Paragraph 50 and, therefore, denies them.

51. Apple denies the allegations in Paragraph 51.

52. Apple denies the allegations in Paragraph 52.

53. Apple admits that the Complaint alleges that the infringing products include at least the Apple’s iPhone, iPad, Apple TV, Mac computer, and Apple Watch and any other products capable of implementing the H.264 standard (collectively, “the Apple Accused Products”). Apple denies that it has committed any act of patent infringement of any valid patent.

54. Apple admits that it received a letter from Nokia dated August 31, 2014 that attached a list of patents, including the ’808 patent, ’469 patent, ’273 patent, ’764 patent, ’005 patent, ’211 patent, and ’701 patent, but not the ‘974 patent. Apple admits that it had knowledge of the existence of the Patents-in-Suit at least as of the date of service of this Complaint. Apple denies the remaining allegations set forth in Paragraph 54 of the Complaint.

GENERAL ALLEGATIONS

55. Apple denies the allegations in Paragraph 55.

56. Apple denies the allegations in Paragraph 56.

57. Apple denies the allegations in Paragraph 57.

58. Apple admits that Plaintiffs have identified at least one allegedly infringed claim per patent in the Complaint. Apple denies that it has committed any act of infringement of any valid patent.

THE ACCUSED PRODUCTS

59. Apple admits that at least certain Accused Products support H.264. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 59.

60. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 60.

61. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 61.

62. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 62.

63. Apple denies the allegations set forth in Paragraph 63.

64. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations set forth in Paragraph 64.

65. Apple admits that at least certain Accused Products support H.264. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 65.

PUBLIC REDACTED VERSION OF DOCUMENT FILED UNDER SEAL

66. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 66.

67. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 67.

68. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 68.

69. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 69.

70. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 70.

71. Apple denies the allegations set forth in Paragraph 71.

72. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations set forth in Paragraph 72.

73. Apple admits that at least certain Accused Products support H.264. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 73.

74. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 74.

75. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 75.

76. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 76.

77. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 77.

78. Apple denies the allegations set forth in Paragraph 78.

79. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations set forth in Paragraph 79.

80. Apple admits that at least certain Accused Products support H.264. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 80.

81. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 81.

PUBLIC REDACTED VERSION OF DOCUMENT FILED UNDER SEAL

82. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 82.

83. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 83.

84. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 84.

85. Apple denies the allegations set forth in Paragraph 85.

86. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations set forth in Paragraph 86.

87. Apple admits that at least certain Accused Products support H.264. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 87.

88. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 88.

89. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 89.

90. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 90.

91. Apple denies the allegations set forth in Paragraph 91.

92. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations set forth in Paragraph 92.

93. Apple admits that at least certain Accused Products support H.264. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 93.

94. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 94.

95. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 95.

96. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 96.

97. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 97.

98. Apple denies the allegations set forth in Paragraph 98.

99. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations set forth in Paragraph 99.

100. Apple admits that at least certain Accused Products support H.264. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 100.

101. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 101.

102. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 102.

103. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 103.

104. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 104.

105. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 105.

106. Apple denies the allegations set forth in Paragraph 106.

107. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations set forth in Paragraph 107.

108. Apple admits that at least certain Accused Products support H.264. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 108.

109. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 109.

110. Apple denies that it has committed any act of infringement of any valid patent. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations of Paragraph 110.

111. Apple denies the allegations set forth in Paragraph 111.

112. The contents of the document cited by Plaintiffs speak for themselves. Apple denies the remaining allegations set forth in Paragraph 112.

COUNT I: ALLEGED INFRINGEMENT OF THE ’808 PATENT

113. Apple incorporates by reference the preceding paragraphs as though fully set forth herein.

114. Apple denies the allegations set forth in Paragraph 114.

115. Apple denies the allegations set forth in Paragraph 115.

116. Apple admits that it received a letter from Nokia dated August 31, 2014, that attached a list of patents, including the ’808 patent. Apple denies the remaining allegations of Paragraph 116.

117. Apple denies the allegations set forth in Paragraph 117.

118. Apple denies the allegations set forth in Paragraph 118.

119. Apple denies the allegations set forth in Paragraph 119.

COUNT II: ALLEGED INFRINGEMENT OF THE ’469 PATENT

120. Apple incorporates by reference the preceding paragraphs as though fully set forth herein.

121. Apple denies the allegations set forth in Paragraph 121.

122. Apple denies the allegations set forth in Paragraph 122.

123. Apple admits that it received a letter from Nokia dated August 31, 2014, that attached a list of patents, including the ’469 patent. Apple denies the remaining allegations of Paragraph 123.

124. Apple denies the allegations set forth in Paragraph 124.

125. Apple denies the allegations set forth in Paragraph 125.

126. Apple denies the allegations set forth in Paragraph 126.

COUNT III: ALLEGED INFRINGEMENT OF THE ’273 PATENT

127. Apple incorporates by reference the preceding paragraphs as though fully set forth herein.

128. Apple denies the allegations set forth in Paragraph 128.

129. Apple denies the allegations set forth in Paragraph 129.

130. Apple admits that it received a letter from Nokia dated August 31, 2014, that attached a list of patents, including the ’273 patent. Apple denies the remaining allegations of Paragraph 130.

131. Apple denies the allegations set forth in Paragraph 131.

132. Apple denies the allegations set forth in Paragraph 132.

133. Apple denies the allegations set forth in Paragraph 133.

COUNT IV: ALLEGED INFRINGEMENT OF THE ’764 PATENT

134. Apple incorporates by reference the preceding paragraphs as though fully set forth herein.

135. Apple denies the allegations set forth in Paragraph 135.

136. Apple denies the allegations set forth in Paragraph 136.

137. Apple admits that it received a letter from Nokia dated August 31, 2014, that attached a list of patents, including the ’764 patent. Apple denies the remaining allegations of Paragraph 137.

138. Apple denies the allegations set forth in Paragraph 138.

139. Apple denies the allegations set forth in Paragraph 139.

140. Apple denies the allegations set forth in Paragraph 140.

COUNT V: ALLEGED INFRINGEMENT OF THE ’005 PATENT

141. Apple incorporates by reference the preceding paragraphs as though fully set forth herein.

142. Apple denies the allegations set forth in Paragraph 142.

143. Apple denies the allegations set forth in Paragraph 143.

144. Apple admits that it received a letter from Nokia dated August 31, 2014, that attached a list of patents, including the ’005 patent. Apple denies the remaining allegations of Paragraph 144.

145. Apple denies the allegations set forth in Paragraph 145.

146. Apple denies the allegations set forth in Paragraph 146.

147. Apple denies the allegations set forth in Paragraph 147.

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COUNT VI: ALLEGED INFRINGEMENT OF THE ’211 PATENT

148. Apple incorporates by reference the preceding paragraphs as though fully set forth herein.

149. Apple denies the allegations set forth in Paragraph 149.

150. Apple denies the allegations set forth in Paragraph 150.

151. Apple admits that it received a letter from Nokia dated August 31, 2014, that attached a list of patents, including the ’211 patent. Apple denies the remaining allegations of Paragraph 151.

152. Apple denies the allegations set forth in Paragraph 152.

153. Apple denies the allegations set forth in Paragraph 153.

154. Apple denies the allegations set forth in Paragraph 154.

COUNT VII: ALLEGED INFRINGEMENT OF THE ’701 PATENT

155. Apple incorporates by reference the preceding paragraphs as though fully set forth herein.

156. Apple denies the allegations set forth in Paragraph 156.

157. Apple denies the allegations set forth in Paragraph 157.

158. Apple admits that it received a letter from Nokia dated August 31, 2014, that attached a list of patents, including the ’211 patent. Apple denies the remaining allegations of Paragraph 158.

159. Apple denies the allegations set forth in Paragraph 159.

160. Apple denies the allegations set forth in Paragraph 160.

161. Apple denies the allegations set forth in Paragraph 161.

PUBLIC REDACTED VERSION OF DOCUMENT FILED UNDER SEAL

COUNT VIII: ALLEGED INFRINGEMENT OF THE '974 PATENT

162. Apple incorporates by reference the preceding paragraphs as though fully set forth herein.

163. Apple denies the allegations set forth in Paragraph 163.

164. Apple denies the allegations set forth in Paragraph 164.

165. Apple admits that it received notice of the '974 patent as of the filing of this Complaint on December 21, 2016. Apple denies the remaining allegations of Paragraph 165.

166. Apple denies the allegations set forth in Paragraph 166.

167. Apple denies the allegations set forth in Paragraph 167.

168. Apple denies the allegations set forth in Paragraph 168.

DAMAGES

169. Apple denies that Plaintiffs are entitled to any relief in this action, requested or otherwise. Apple denies the allegations set forth in Paragraph 289.

DEMAND FOR JURY TRIAL

170. In accordance with Fed. R. Civ. P. 28(b), Apple demands a trial by jury on all issues so triable.

PRAYER FOR RELIEF

Apple denies that Plaintiffs are entitled to any relief in this action, requested or otherwise.

DEFENSES TO PLAINTIFFS' COMPLAINT

Apple alleges and asserts the following defenses in response to the allegations above, undertaking the burden of proof only as to those defenses deemed affirmative defenses by law, regardless of how such defenses are denominated herein.

First Defense (Non-Infringement)

Plaintiffs are not entitled to any relief against Apple because Apple has not infringed and is not infringing, either directly, contributorily, or by inducement, either literally or under the doctrine of equivalents, any valid and enforceable claim of any of the '808 patent, '469 patent, '273 patent, '764 patent, '005 patent, '211 patent, '701 patent, and '974 patent (the "Asserted Patents").

Second Defense (Invalidity)

One or more of the claims of the Asserted Patents are invalid for failing to meet one or more of the requisite statutory and decisional requirements and/or conditions for patentability under Title 35 of the United States Code, including without limitation, §§ 101, 102, 103, and 112.

Third Defense (Authority to Practice and/or Unenforceability)

One or more of the asserted patents are unenforceable against Apple because of estoppel, laches, waiver, unclean hands, patent exhaustion, license/covenants not to assert, implied license/covenants not to assert, and/or other contractual or equitable doctrines.

To the extent any of the Asserted Patents are substantially embodied in components that Apple purchases from any manufacturer Plaintiffs have contractually authorized to manufacture components that practice the Asserted Patents, these suppliers have made authorized sales of those components to Apple that exhausts those patents, and Plaintiffs are not entitled to enforce those patents against Apple.

As to waiver and estoppel, with respect to the asserted patents that Plaintiffs claims are essential to the H.264 standard, Nokia has engaged in standard-setting misconduct, including without limitation, Nokia's making false commitments to the ITU to license declared essential H.264 patents on RAND terms, as set forth more fully below in Apple's Counterclaims.

Fourth Defense (No Injunctive Relief)

To the extent that Plaintiffs seek injunctive relief for alleged infringement, the relief it seeks is unavailable because (i) Apple is entitled to sell products that incorporate components that it purchases from Plaintiffs' licensed suppliers, and (ii) seeking injunctive relief is contrary to Nokia's commitment to ITU to license its claimed essential H.264 patents on RAND terms and Apple's irrevocable right to obtain a license by virtue of Nokia's RAND commitments. In addition, the alleged injury to Nokia is not immediate or irreparable, and Nokia has an adequate remedy at law for any alleged injury.

Fifth Defense (Limitation on Damages)

Plaintiffs' right to seek damages and other remedies from Apple is limited by 35 U.S.C. §§ 286 and/or 287.

Sixth Defense (Reservation of Defenses)

Apple reserves all defenses under Rule 8(c) of the Federal Rules of Civil Procedure, the patent laws of the United States, and any other defenses, at law or in equity, that may now exist or in the future be available based on discovery and further investigation in this case.

COUNTERCLAIMS

Counterclaim Plaintiff Apple Inc. ("Apple"), on personal knowledge as to its own acts, and on information and belief as to all others based on its own and its attorneys' investigation, alleges Counterclaims against Nokia Technologies Oy, Nokia Corporation, and Alcatel-Lucent USA Inc. (collectively, "Nokia") as follows:

NATURE OF ACTION

1. In its Complaint, Nokia alleges that Apple has infringed patents essential to the H.264 video standard. Apple asserts these counterclaims to address and remedy Nokia's continuing pattern of abuse regarding patents it now asserts. Nokia deliberately made a series of false promises to license its claimed standard essential patents (SEPs) for the H.264 standard on reasonable and non-discriminatory (RAND) terms and conditions. Nokia's conduct has resulted in harm to U.S. industry, U.S. consumers of products like cell phones and tablet consumers, and product innovators like Apple.

2. Nokia alleges that it declared these purportedly essential patents to the International Telecommunications Union (ITU)—an international standard setting organization (SSO) involved in developing the H.264 standard—and committed to license the purportedly essential claims of the asserted patents on RAND terms and conditions.

3. In disregard of its acknowledged RAND obligations, Nokia has refused to offer Apple a license to its declared H.264 patents on RAND terms, notwithstanding Apple's longstanding offer to license those patents on such terms. In further breach of its RAND obligations, Nokia is now seeking an injunction against Apple, attempting to coerce Apple into capitulating and paying excessive, non-RAND royalties.

4. Moreover—through its false RAND commitments—Nokia illegally obtained monopoly power and positioned itself to make abusive demands based on its purported H.264 SEPs. Apple has suffered ongoing harm based on the costs, burdens, and business uncertainties associated with defending against Nokia's outrageous demands and this litigation. Unless stopped, Nokia's anticompetitive and abusive conduct will lead to inflated, non-RAND royalties being imposed on Apple and other product innovators and, ultimately, higher prices and reduced innovation and quality for U.S. consumers purchasing products that support the H.264 standard. Nokia's conduct further harms competition by undermining and reducing the efficacy of beneficial standard-setting.

5. Through these counterclaims, Apple seeks to put an end to and remedy Nokia's unlawful monopolization, breaches of its RAND commitments, and violations of the California Unfair Competition Law.

PARTIES

6. Counterclaimant Apple Inc. is a California corporation with its principal place of business at 1 Infinite Loop, Cupertino, California 95014.

7. On information and belief, counterclaim-defendant Nokia Technologies Oy (Nokia Technologies) is a Finnish corporation that, according to Nokia Corporation's website, is headquartered in Sunnyvale, California.[3] Nokia Technologies was incorporated on November 26, 2014. Nokia Technologies is alleged to be the sole owner by assignment of all right, title,

[3] *See* Nokia Corporation Website, *Nokia Technologies*, https://www.nokia.com/en_int/about-us/who-we-are/our-businesses/nokia-technologies (accessed Feb. 28, 2017) (listing headquarters as Sunnyvale, CA); *see also* Chris O'Brien, *Nokia Technologies President on the Future of His 'Startup': 'Anything Is Possible,'* Venturebeat, (Feb. 18, 2017), http://venturebeat.com/2016/08/22/nokia-technologies-president-on-the-future-of-his-startup-anything-is-possible/ (describing Nokia Technologies as "based in Sunnyvale" and "a startup within Nokia, but based in Silicon Valley").

and interest of certain patents that are the subject of the Complaint and are the subject of these counterclaims.

8. Counterclaim-defendant Nokia Corporation is a public limited liability company incorporated under the laws of the Republic of Finland.

9. On information and belief, counterclaim-defendant Alcatel-Lucent USA Inc. is a Delaware corporation that, according to its website, is headquartered in Murray Hill, New Jersey. On information and belief, Alcatel-Lucent USA Inc. merged with Nokia in January 2016.

JURISDICTION AND VENUE

10. The Court has jurisdiction over these Counterclaims pursuant to the Federal Patent Act, 28 U.S.C. §§ 1338(a), 2201, 2202, pursuant to 15 U.S.C. § 4, and pursuant to 28 U.S.C. §§ 1331, 1337.

11. The Court also has supplemental jurisdiction over the state law counterclaims under 28 U.S.C. § 1367 because the state and federal claims arise from a common nucleus of operative facts.

12. Nokia Technologies has subjected itself to personal jurisdiction by filing its Complaint against Apple in this Court. Nokia Corporation has similarly availed itself of the laws of this state and the jurisdiction of this Court by directing Nokia Technologies, one of Nokia's two business units, to initiate this litigation. Additionally, Nokia Corporation was involved in the licensing discussions relevant to these claims.

13. Apple believes that a change of venue should be ordered pursuant to 28 U.S.C. § 1404(a). To the extent that such a change of venue is not ordered, venue over these counterclaims is proper in this judicial district pursuant to 28 U.S.C. § 1367 insofar as venue is proper over the Plaintiffs' claims.

INDUSTRY TECHNICAL STANDARDS

14. Industry technical standards have the potential to encourage innovation, enable interoperability of products, and promote competition among equipment suppliers. Standards assure suppliers and consumers of products that support the standard that their products will interoperate with products supplied by others. This assurance enables suppliers to invest in design, development, and marketing to provide end consumers products that they desire.

15. Standards also reduce costs for suppliers and end consumers. For suppliers, standardization lowers costs and promotes increased output. End consumers benefit from increased price, innovation, and quality competition among suppliers that produce products that support a common standard.

16. Absent appropriate rules and adherence thereto, however, standards can lead to anticompetitive abuses. Before a standard is adopted, suppliers of various technologies compete with other suppliers that offer similar functionality to product suppliers. Before standardization, the royalty a patent owner can demand is constrained by the availability of alternative technical approaches to perform the functionality claimed in the patent. Post-standardization, however, former alternatives to perform the standardized functions are often no longer viable substitutes and thus no longer constrain royalties relating to standardized technology.

17. This is because once a product supplier decides to implement a standard, it makes significant investments in designing and sourcing its products to be compatible with the standard, and is thus locked in to the standard. It would be prohibitively expensive to start over with a new technology or a new standard, even assuming that were technically feasible. Unless holders of declared SEPs respect the rules governing standard-setting, suppliers making huge investments in products that support the standard can be exploited by declared SEP holders that seek

exorbitant royalties based not on the inventive value of their technology, but rather on the fact their technology has purportedly been standardized.

18. Recognizing the potential for abuse by holders of declared SEPs, most SSOs have adopted intellectual property right (IPR) policies that are intended to minimize the potential for exploitation.

19. IPR policies generally require SSO participants claiming to own IPR that might cover standardized technology to commit to license such technology on RAND terms. These binding commitments are essential checks on the anticompetitive risks posed by standardization. If the patent holder refuses to commit to license on RAND terms, SSO rules typically state that either another technology should be selected for the standard or that the function covered by the patented technology should not be standardized.

20. Breaching RAND commitments, such as by refusing to offer RAND licenses to declared SEPs or seeking to enjoin suppliers of products that support the standard (notwithstanding a commitment to accept RAND royalties as sole compensation for practicing a declared SEP)—as Nokia has done here—undermines and circumvents the safeguards that SSOs enact to guard against abuse. That, in turn, causes anticompetitive harm to product suppliers and end consumers alike, undermines the procompetitive aspects of standard-setting, and chills incentives to participate in beneficial standard-setting.

THE H.264 STANDARD

21. Nokia's unlawful conduct concerns patents it claims are essential to the H.264 standard, a standard for video compression developed by the Joint Video Team (JVT) and jointly promulgated by the ITU and the International Organization for Standardization /International Electrotechnical Commission ("ISO/IEC").

22. The JVT is a collaborative group composed of (1) the Motion Picture Experts Group (MPEG), the video subgroup of the ISO/IEC and (2) the Video Coding Experts Group (VCEG), a subgroup of the ITU.[4] The ITU's VCEG performed the early development of the standard, and the JVT was created in 2001 to finalize it. The first version of H.264, also known as MPEG-4 Part 10, or Advanced Video Coding (AVC), was adopted in May 2003.

23. As a member of the ITU, Nokia participated in the early development of the standard that would become H.264, even before the JVT was formed. Through its ITU membership, Nokia continued to participate in the H.264 standard-setting process under the auspices of the JVT. The JVT operated as a "joint group under the ordinary policies and procedures of both organizations," and committed to working in compliance with the IPR policies, reporting requirements, and procedures of the ITU and the ISO/IEC.[5]

24. H.264 video compression technology was designed for use in a "wide range of applications such as high-resolution video broadcast and storage, mobile video streaming (Internet and broadcast), and professional applications such as cinema content storage and transmission."[6] According to the ITU, H.264 "represents an evolution of the existing video coding standards" and "was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, Internet streaming, and communication."[7]

25. H.264 is the most popular method of coding video content. Apple has invested billions of dollars in products that support the H.264 standard, and it would take years for Apple

[4] *See* MPEG, "MPEG-4 Advanced Video Coding," http://mpeg.chiariglione.org/standards/mpeg-4/advanced-video-coding (accessed Feb. 28, 2017).
[5] ITU, Terms of Reference for the Joint Video Team (JVT) Activities, available at http://www.itu.int/oth/T3401000001/en (accessed Feb. 28, 2017).
[6] MPEG, "MPEG-4 Advanced Video Coding," http://mpeg.chiariglione.org/standards/mpeg-4/advanced-video-coding (accessed Feb. 28, 2017)..
[7] ITU-T, "Summary," https://www.itu.int/dms_pubrec/itu-t/rec/h/T-REC-H.264-201610-I!!SUM-HTM-E.htm (accessed Feb. 28, 2017).

and the industry to develop software and hardware that uses alternative techniques. Furthermore, even if Apple could employ alternative techniques in the future, it would be incompatible with prior versions of software and hardware that support the H.264 standard. Moreover, the vast majority of video content available for display on Apple products uses H.264, and transcoding that content to a new standard would be prohibitively expensive and time-consuming. In short, Apple presently has no economically viable option to use an alternative video coding technique in place of H.264.

26. In addition to designing products that support the H.264 standard, Apple was an active participant in the technical development of several key features of that standard. Specifically, Apple's engineers have developed inventions adopted in the H.264 standard that are embodied in a series of patents by current and former Apple engineers Barin Haskell, David Singer, Adriana Dumitras, and Atul Puri.

27. On June 16, 2009, the U.S. Patent and Trademark Office ("USPTO") duly and legally issued U.S. Patent No. 7,548,584 ("the '584 Patent"), entitled "Using Order Value for Computing Motion Vector." A true and correct copy of the '584 Patent is attached hereto as Exhibit 1.

28. On January 3, 2012, the USPTO duly and legally issued U.S. Patent No. 8,090,026 ("the '026 Patent"), entitled "Using Order Difference for Calculating Motion Vector." A true and correct copy of the '026 Patent is attached hereto as Exhibit 2.

29. On January 14, 2014, the USPTO duly and legally issued U.S. Patent No. 8,630,339 ("the '339 Patent"), entitled "Method and Apparatus for Variable Accuracy Inter-Picture Timing Specification for Digital Video Encoding." A true and correct copy of the '339 Patent is attached hereto as Exhibit 3.

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30. On May 27, 2014, the USPTO duly and legally issued U.S. Patent No. 8,737,484 ("the '484 Patent"), entitled "Method and Apparatus for Variable Accuracy Inter-Picture Timing Specification for Digital Video Encoding." A true and correct copy of the '484 Patent is attached hereto as Exhibit 4.

31. The '584, '026, '339, and '484 Patents are collectively referred to as the "Apple H.264 Patents."

32. Apple exclusively owns all rights, title, and interest in the Apple H.264 Patents, including the right to recover past and future damages.

33. Apple has included its H.264 Patents in the MPEG LA patent pool, and dozens of companies have licensed the Apple H.264 Patents through the pool. Nokia has chosen not to take the MPEG LA Patent Portfolio License and is infringing the Apple H.264 Patents. Apple has also offered Nokia a license to its H.264 Patents, but Nokia has not been willing to reciprocate and license its H.264 patents to Apple on RAND terms.

RELEVANT INPUT TECHNOLOGY MARKETS

34. For purposes of Apple's antitrust and unfair competition counterclaims, the relevant markets encompass technologies that compete or formerly competed to perform each of the various functions that Nokia claims are covered by the asserted patents. These are referred to collectively as the "Input Technology Markets." Each Input Technology Market comprises its own relevant antitrust market.

35. Once ITU adopts a technology as part of the H.264 standard, the owner of a declared SEP purportedly covering that technology obtains monopoly power in that Input Technology Market. When a technology is incorporated into the H.264 standard, alternatives to

the technology are eliminated, and suppliers seeking to sell products that support the standard have no option but to use the technology. Nokia holds monopoly power in each of the relevant Input Technology Markets whether or not the declared SEP is actually valid, infringed, and enforceable. Merely by asserting that a patent is essential, Nokia is able to extract royalties or other licensing terms for that patent greatly exceeding what it could have obtained before ITU standardized the technology Nokia claims is covered by its patent. Nokia enjoys that power because, absent a license, a party using the H.264 standard must engage in lengthy and expensive litigation over infringement, validity, and enforceability of the relevant declared SEP. When Nokia (improperly) brings injunction claims, like it has here, the product supplier faces the risk of an injunction against all of its products that support the H.264 standard. Moreover, Nokia's monopoly power is enhanced because Nokia holds a large portfolio of patents claimed to be essential to the H.264 standard. By amassing a large portfolio and asserting multiple patents (with the risk that still more can be asserted), Nokia obtains even more leverage based on the enormous costs and burdens associated with challenging Nokia's serial infringement claims.

36. Barriers to entry into the relevant Input Technology Markets are high because, among other reasons, the post-standardization lock-in effect means that other technologies are no longer viable substitutes for the patented technologies that the standard specifies to perform functions included in the standard.

37. Alternative technologies competing to provide functionality that was incorporated into the H.264 standard were offered by suppliers from around the world. Accordingly, the geographic scope of each of the Input Technology Markets is worldwide.

38. After the H.264 standard was adopted, Nokia obtained monopolies in the Input Technology Markets associated with its declared H.264 SEPs.

39. With the possible exception of the ’974 patent (which Nokia apparently does not assert to be essential to the H.264 standard), Nokia acquired monopoly power in Input Technology Markets encompassing each of the patents Nokia asserts in this case. Nokia acquired that monopoly power as a result of misconduct during the standard-setting process, including through its false RAND commitments.

NOKIA’S ANTICOMPETITIVE MISCONDUCT BEFORE H.264 SSOs

40. During and after the H.264 standard-setting process, Nokia made intentionally false RAND commitments and failed to disclose that it had no intention of offering licenses to its declared SEPs on RAND terms. This misconduct violated Nokia’s obligations to the ITU and were part of a scheme to induce the SSOs developing H.264 to standardize technology that Nokia claims is covered by its declared SEPs and refuses to license on RAND terms.

41. At all times relevant to these allegations Nokia was a member of the ITU-T and actively participated in the ITU-T’s and JVT’s development of the H.264 standard.[8] Because of this membership and participation in the H.264 standard-setting process, Nokia was and is bound by the ITU’s Patent Policy and Guidelines for Implementation (now known as the Common Patent Policy for the ITU-T/ITU-R/ISO/IEC). As the assignee of Nokia Corporation’s H.264 patents, Nokia Technologies Oy is bound by the commitments Nokia Corporation made to the ITU.

[8] The ITU-T is the sector of the ITU that focuses on standardization. The ITU-T “assembles experts from around the word to develop international standards known as ITU-T Recommendations, which act as defining elements of the global infrastructure of information and communication technologies.” ITU, https://www.itu.int/en/join/Pages/default.aspx (accessed Feb. 28, 2017).

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42. The policy in effect when Nokia began participating in the development of H.264 specifies three potential scenarios after an organization, as required by the IPR Policy, discloses known patents or patent applications that may be essential to the standard under consideration:

> 2.1 The patent holder waives his rights; hence, the Recommendation is freely accessible to everybody, subject to no particular conditions, no royalties are due, etc.
>
> 2.2 The patent holder is not prepared to waive his rights but would be willing to negotiate licenses with other parties on a non-discriminatory basis on reasonably terms and conditions. Such negotiations are left to the parties concerned and are performed outside the ITU-T.
>
> 2.3 The patent holder is not willing to comply with the provisions of either paragraph 2.1 or paragraph 2.2; in such case, no Recommendation can be established.[9]

43. The Guidelines specify that the disclosure and licensing requirements extend to patents that potentially cover technology incorporated in a standard after the standard has been published. In such cases, "[i]f the patent holder is unwilling to license or waive its rights, the Recommendation will need to be revised or withdrawn and its publication suspended."[10]

A. False RAND Commitments

44. Nokia made intentionally false RAND commitments for IPR it declared as essential to the H.264 standard. For IPR purportedly covering aspects of the H.264 standard that had not yet been finalized, Nokia intended this deception to ensure that the ITU—which was relying on Nokia to make truthful representations—would incorporate technologies in the standard that Nokia claims are covered by its patents and eliminate alternatives in the Input Technology Markets. For IPR purportedly covering aspects of the H.264 standard that already had been published, Nokia's false RAND commitments were intended to ensure that ITU did not revise or withdraw the Recommendation incorporating technology purportedly covered by Nokia's IPR, as it would have been required to do. *See supra*, ¶ 34. Nokia's false RAND

[9] ITU, Guidelines for Implementation of the TSB Patent Policy (July 7, 1999), at p. 7 (Appendix I).
[10] *Id.*at 6 (Section 6).

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commitments positioned Nokia to take advantage of its ill-gotten monopoly power to demand exorbitant royalties and unreasonable terms for its declared H.264 SEPs—like it has done in the course of its dealings with Apple over the patents it now asserts in this litigation.

45. Nokia breached both (i) its general commitment it made to the ITU to license on RAND term all patents essential to any ITU standard and (ii) the H.264-specific RAND commitments it made in its individual Patent Statement and Licensing Declarations ("Licensing Declarations").

46. On June 7, 2001 Nokia submitted to the ITU a false General Patent Statement and Licensing Declaration:

> In case part(s) or all of any proposals contained contributions submitted by [Nokia Corporation] are included in ITU-T Recommendation(s) and the included part(s) contain items that have been patented or for which patent applications have been filed and those whose use would be required to implement the ITU Recommendation(s), [Nokia Corporation] hereby declares, in accordance with the Statement on ITU-T Patent Policy. . . that . . . [t]he Patent Holder is prepared to grant on the basis of reciprocity for the relevant ITU-T Recommendation(s)—a license to an unrestricted number of applicants on a worldwide, nondiscriminatory basis and on reasonable terms and conditions.

47. Nokia also submitted individual Patent Declarations, which made the following false RAND commitment with respect to specific technology it believed to be essential to the H.264 standard:

> The Patent Holder is prepared to grant a license to an unrestricted number of applicants on a worldwide, non-discriminatory basis and on reasonable terms and conditions to make, use and sell implementations of [ITU-T H.264 / ISO/IEC 14496-10].

In particular, Nokia submitted at least the following false IPR declarations:

- On behalf of Nokia Corporation, Jari Vaario, Director IPR, signed a Patent Statement and Licensing Declaration on March 19, 2007, that Nokia submitted to the ITU. Page 3 of the Declaration includes the U.S. patent application that was part of the same patent family as '808 patent.

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- On behalf of Nokia Corporation, Jari Vaario, Director IPR, signed a Patent Statement and Licensing Declaration on March 19, 2007, that Nokia submitted to the ITU. Page 3 of the Declaration includes the ’005 patent, to which the ’764 patent is a continuation.

- On behalf of Nokia Corporation, Kalle Moilanen, IPR Manager, signed a Patent Statement and Licensing Declaration on October 11, 2010, that Nokia submitted to the ITU. Page 3 of the Declaration includes the ‘’701 patent.

- On behalf of Nokia Corporation, Stephen Wagner, Sr. IPR Manager, signed a Patent Statement and Licensing Declaration on June 26, 2007, that Nokia submitted to the ITU. Page 3 of the Declaration includes the ’469 patent, to which the ’273 patent is a continuation.

a. Nokia’s Anticompetitive Deceit Caused Standard Developers To Exclude Alternative Technologies In The Input Technology Markets From H.264

48. Nokia’s deliberately false RAND commitments with respect to its patents in the Input Technology Markets were intended to and did cause the H.264 standard developers to incorporate technology that Nokia now claims is covered by its declared SEPs. Had Nokia not made false RAND commitments, the ITU would have decided to standardize an alternative technology to perform the relevant functions. Alternately, the ITU would have left the relevant function out of the standard, allowing H.264 implementers to choose among alternative technologies. In either case, but for Nokia’s false commitments, alternative viable technologies would not have been excluded from the Input Technology Markets, and Nokia would not have obtained illegal monopolies in those Markets.

49. Similarly, Nokia’s false RAND commitments made after Nokia’s technology was allegedly incorporated into the H.264 standard were intended to and did cause the H.264 standard developers to not revise or withdraw the relevant Recommendation covered by its purported SEPs.

50. For each of the declared SEPs asserted here, on information and belief, the ITU had multiple viable alternative technologies. *Ericsson, Inc. v. D-Link Sys., Inc.*, 773 F.3d 1201,

1233 (Fed. Cir. 2014) ("When a technology is incorporated into a standard, it is typically chosen from among different options."). Yet, instead of standardizing one of these alternative technologies or leaving the relevant functionality out of the standard, the ITU standardized technology Nokia now claims is covered by its declared SEPs.

51. Because of Nokia's false RAND commitments, technology that Nokia purports is covered by the asserted patents was standardized and/or continued to be standardized instead of alternative technologies. Through these acts of deception, Nokia distorted and impaired the competitive process during standard-setting and gained and maintained illegal monopolies in the Input Technology Markets.

BREACH OF RAND OBLIGATIONS

52. Nokia's RAND declarations are binding contractual commitments made to the ITU and other SSOs participating in the H.264 standard development for the benefit of the SSOs, their members, and any entity that uses H.264, including Apple.

53. Apple, other members of the SSOs, and entities implementing H.264 reasonably relied on the ITU's rules for standard setting and Nokia's RAND commitments purportedly made in compliance with those rules in supplying products that support the H.264 standard. Apple has invested massive resources in developing and marketing its products in reliance on the RAND commitments Nokia made regarding declared SEPs purportedly covering technology incorporated in the H.264 standard.

54. Indeed, Nokia acknowledges its obligation to license its declared SEPs on RAND terms. *See* Complaint ¶ 21. Yet Nokia's conduct throughout its negotiations with Apple—

leading up to and including the filings of its Complaint seeking an injunction on the basis of its declared SEPs—constitutes a breach of its RAND obligations.

55. Nokia and Apple have been negotiating a license to Nokia's purported H.264 SEPs for more than two years, a process that has been both protracted and unsuccessful due to: (1) Nokia's resistance to providing patent merit and infringement details that would allow Apple to meaningfully assess Nokia's claims; (2) Nokia's insistence on executing an unfair and imbalanced NDA that would unduly restrict Apple from challenging Nokia's patents or RAND adherence before it would engage in meaningful negotiations or make an offer; (3) Nokia's refusal to offer a license on RAND terms, and (4) Nokia's refusal to agree to arbitration on terms that are fair and would account for Apple's concerns about the merits of Nokia's patent claims, including validity, enforceability, and infringement. Moreover, Nokia has attempted to pressure Apple into forgoing a meaningful analysis of Nokia's patents' merits by unilaterally declaring Apple an "unwilling licensee," effectively threatening that Nokia would seek injunctive relief (which it has now done). But throughout the parties' negotiations, and to this day, Apple remains willing to license on RAND terms any valid and enforceable Nokia patents that Apple is actually using.

56. On August 31, 2014, Nokia accused Apple of infringing Nokia patents, including certain patents it alleged were essential to the H.264 standard.

57. Apple promptly responded that it was reviewing the materials provided by Nokia and, on September 18, 2014, wrote to Nokia to notify it that the materials provided with respect to Nokia's alleged H.264-related patents were insufficient, and Apple would need more information, such as claim charts, to meaningfully investigate Nokia's allegations. On October 13, 2014, Apple repeated its request for more information. On October 15, 2014, Nokia

questioned Apple's need for additional information and declined to provide any claim charts for its alleged H.264-related patents, instead stating that it would explain the relevance of the H.264 standard to Nokia's patents during an in-person meeting. Such refusals became Nokia's regular practice, as Apple repeatedly requested, and Nokia repeatedly resisted providing, sufficient detail on how Nokia's patents were allegedly infringed and specifically how they were implicated in H.264.

58. Thereafter, Apple and Nokia spent several months negotiating an NDA, which Nokia insisted on having in place before engaging in in-depth technical discussions, but that Apple maintained was unnecessary because the patents and the H.264 standard are public. Nokia's restrictive NDAs are part of its strategy to prevent licensees both from challenging Nokia's patents and from obtaining information that would be relevant to evaluating whether Nokia is complying with its RAND obligations.

59. [redacted]

60. [redacted]

[redacted]

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[redacted]

61. [redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted] The same day, Nokia filed the present suit

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against Apple, seeking, among other things, an injunction precluding Apple from infringing its patents, including declared SEPs.

[redacted]

69. Nokia has acted abusively and in breach of its RAND commitments throughout the course of these negotiations. Among other things, Nokia has:

- Repeatedly refused to provide Apple with the information Apple needed to meaningfully assess Nokia's infringement allegations and assess RAND compliance;
- Refused to offer licenses on RAND terms;
- Refused to provide any reasoned explanation as to why the terms Apple proposed were not RAND;
- Refused to accept Apple's RAND counteroffers; and
- Sought an injunction on its declared SEPs, despite its RAND commitments and Apple's license offers.

A. Nokia's Proposed Royalty Was Inconsistent with RAND Principles

70. Nokia has demand exorbitant royalties and has failed to provide any defensible valuation methodology. Nokia has not justified its offers to its H.264 portfolio under RAND principles, and cannot do so.

71. It is well accepted that RAND royalties should reflect the technical contribution of the claimed invention only, not the value of an entire standard, not the "hold up" value derived from a particular patent's inclusion in the standard, and certainly not the value of product features wholly unrelated to the claimed invention. This can be achieved by basing the royalty on the smallest saleable unit, or a portion thereof, that embodies the patented functionality and apportioning further to the value of the claimed invention. The royalty derived from that base, however, must also recognize royalties owed to other patent holders on the same base to avoid

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"royalty stacking." A reasonably royalty must not lead to an objectively unsupportable aggregate royalty burden on a product if all licensors were to adopt the same approach.

72. Nokia's exorbitant license offer reflects complete disregard for these principles, which its communications to Apple confirm. [redacted] Through this position, Nokia is attempting to extract royalties based on the overwhelming proportion of the value of Apple products that bear no connection to the H.264 standard, not technology that Nokia claims is covered by its declared H.264 SEPs.

73. Additionally, Nokia's excessive royalty would result in an unreasonable aggregate royalty burden on implementers of the H.264 standard, a concern Nokia has dismissed as "purely theoretical." Employing Nokia's approach would result in royalties that vastly exceed the cost of the chipset that contains the H.264 technology. This demonstrates that Nokia's royalty rate could not possibly reflect only the technical contribution of its patented technology, as RAND principles require. Rather, Nokia is abusing its status as a declared SEP holder—and its ill-gotten monopoly power—to seek to extract an excessive royalty based on its technology's alleged inclusion in the H.264 standard—a quintessential case of patent hold-up.

74. For example, Nokia has demanded many times more for its patents than the effective royalty rates for patents licensed through the MPEG-LA H.264 pool. This patent pool contains over 4,500 H.264-related patents, over 35 licensors, and over 1,400 licensees.

B. Nokia's Request For An Injunction Is A Breach of RAND Obligations

75. Like its refusal to offer licenses on RAND terms, Nokia's initiation of this litigation seeking injunctive relief based on declared SEPs against Apple (which has consistently made clear that it is willing to take a license on RAND terms) constitutes a breach of Nokia's RAND obligations.

76. In disregard of its RAND commitments, Nokia has engaged in an abusive campaign throughout the world to use its declared H.264 SEPs to seek injunctions against Apple products that support the H.264 standard. When it made its RAND commitment, Nokia agreed to accept a reasonable royalty as its sole compensation from suppliers of products that support the H.264 standard, and then only for declared SEPs that are actually valid, infringed, and enforceable. Yet, in addition to this action, Nokia has also sought injunctions based on declared H.264 SEPs in other litigations throughout the world, in an effort to force Apple to capitulate to Nokia's outrageous, non-RAND royalty demands.

77. Apple has negotiated in good faith and remains willing to license on RAND terms any SEP it is practicing that is valid and enforceable. Apple repeatedly articulated its openness to license on RAND terms and made reasonable offers.

NOKIA'S UNFAIR AND ANTICOMPETITIVE CONDUCT HAS INJURED COMPETITION, CONSUMERS, AND APPLE IN THE RELEVANT TECHNOLOGY MARKETS

78. Nokia's conduct has harmed competition in the Input Technology Markets. If not for Nokia's false commitments to license its patented technologies in the Input Technology Markets on RAND terms, alternative suppliers of technology in the Input Technology Markets would have had their technologies incorporated into the H.264 standard to perform the functions that Nokia claims are covered by its declared SEPs, or those functions would not have been

standardized in the first place. In all events, Nokia's false promises caused it illegally to obtain monopoly power in Input Technology Markets.

79. As a result of Nokia's unlawful monopolization, Apple incurs inflated costs relative to what it would have incurred but for Nokia's unlawful conduct. These costs include not only the threat of supra-competitive royalties, but also the costs, burdens, and business uncertainties associated with this and other litigations regarding Nokia's declared SEPs.

80. Customers for downstream products that support the H.264 standard are also harmed by Nokia's conduct in the form of higher prices and reduced innovation and quality, as well as fewer products that support the H.264 standard.

81. Moreover, as Nokia and other holders of declared SEPs refuse to abide by their RAND commitments, industry loses confidence and refuses to participate (or changes the way it participates) in procompetitive standard-setting processes, resulting in less standardization and its corresponding benefits. This too harms industry and ends product consumers.

82. In sum, Nokia has engaged in an illicit scheme intentionally to (i) make false RAND commitments in order to have its technology incorporated in the standard and (ii) then seek to monetize that deception by making non-RAND demands on Apple and other suppliers of products that support the H.264 standard and pursue an injunction against Apple products through this action. This scheme threatens to erode Apple's market share, customer loyalty, and goodwill.

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GENERAL ALLEGATIONS REGARDING NOKIA'S INFRINGEMENT OF THE APPLE H.264 PATENTS

83. Apple has at all times been willing to license its asserted H.264 on RAND terms and according to the same RAND licensing principles that Nokia is obligated to apply when offering a license to its declared SEPs. Apple's H.264 patents, which are essential to the H.264 standard, are part of the MPEG LA patent pool, which constitutes a standing RAND license offer administrated by the neutral third party patent pool. Additionally, in its offer to license Nokia's H.264 patents of February 1, 2016, Apple affirmed that it is was offering a reciprocal RAND license to all of Apple's H.264 SEPs. Apple has additionally repeatedly offered to mediate to resolve disputes related to both parties' declared SEPs.

84. On information and belief, Nokia manufactures, uses, markets, offers for sale, sells, and/or imports in the United States, or has manufactured, used, marketed, offered for sale, sold, and/or imported in the United States networking and multimedia devices that are compliant with the H.264 video compression standard ("the Nokia H.264 Accused Products").

85. For example, Nokia advertises its OZO Camera with OZO Creator and OZO Live software as being compliant with the H.264 standard:

Introduction

OZO Live enables the revolutionary Nokia OZO VR Camera to be used for live VR broadcasts. It is a software product, running on GPU-assisted reference hardware, which converts the compressed 1.5Gb/sec HD-SDI signal from the OZO into either a standard 4K UHD video signal for live post-production, delivered via quad-link HD-SDI, or an RTMP uplink to a cloud delivery service. OZO Live provides advanced real-time stitching functionality, spatial audio processing, color correction, h.264 encoding, and a variety of advanced options in a powerful and easy-to-use package.

OZO Live is designed for professional broadcast production use. It supports three primary deployment modes: (1) single-camera workflow with direct RTMP uplink; (2) single-camera workflow to a single external broadcast encoder, and (3) multi-camera workflows with full production switching and sound reinforcement. A typical single-camera workflow is diagrammed below:

OZO CREATOR APPLICATION

Supported Operating Systems	Mac OS X® 10.10 Yosemite, Mac OS X® 10.11 El Capitan, Windows 10
Minimum Hardware Requirements	Mac Pro (Late 2013) with Dual AMD FirePro D500. Recommended: D700 PC with quad core-i7 CPU, 16GB RAM, 2 x NVIDIA GTX 1080 GPUs
Editorial Proxy Output MOV	MOV, monoscopic 360 degree panorama, H.264, YUV420

Source: "Ozo Live Best Practices" v. 1.3.0, *available at* https://ozo.nokia.com/media/custom/upload/OZO_Live_Best_Practices_v1.3.0.pdf.

86. As shown below, Nokia promotes the video capture and compression capabilities of the OZO Camera using a dedicated website, ozo.nokia.com. On this website, Nokia provides to its customers detailed specifications for the OZO camera, as well as extensive product support, including How-To Videos, user guides, start guides, and other manuals, all of which are intended

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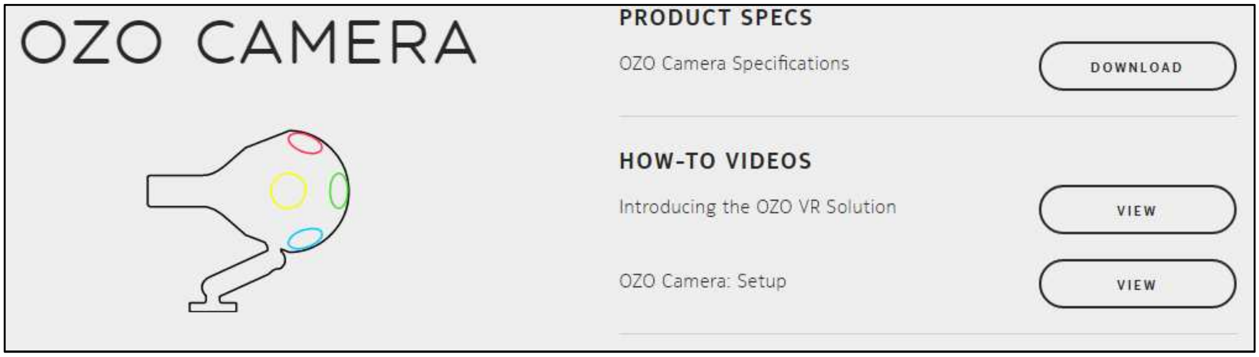
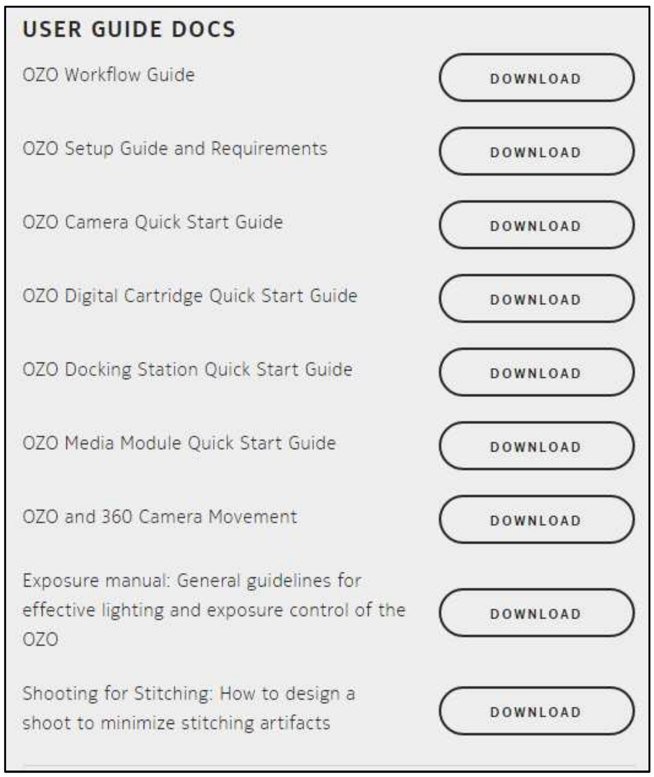
to induce Nokia's customers to use the OZO Camera in compliance with, among other things, the H.264 standard.





Source: "Ozo Resource Library", *available at* https://ozo.nokia.com/ozo_en/resource-library/

87. Similarly, Nokia's literature promoting its 7750 SR router and 7450 ESS switch with MS-ISA or MS-ISM cards implementing the Fast Channel Change ("FCC") and

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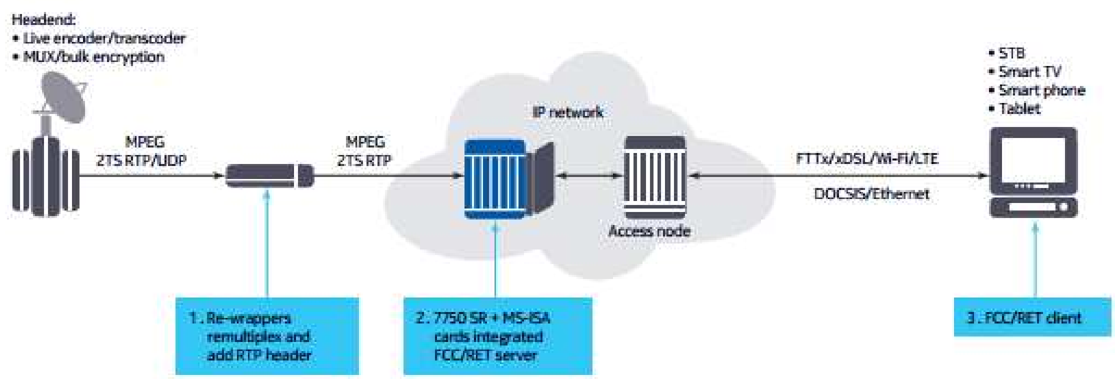
Retransmission ("RET") features, in conjunction with Nokia's Velocix IP video products, states that these products are compliant with the H.264 standard:

Nokia FCC and RET (see Figure 2) are provided by:

- The re-wrapper: A function provided by the Velocix Broadcast Optimizer to support video stream analysis and conditioning for FCC and RET.
- The FCC and RET server: Resides on a card on the Nokia 7750 Service Router (SR). A circular buffer caches and forwards multicast video traffic. This caching and forwarding function is integrated in 7750 SRs on the MS-ISA or MS-ISM card. The FCC and RET functions can be integrated into any existing Layer 2 or Layer 3 network.
- The FCC and RET client: Requests FCC and RET services from the appliance or the VoD servers.

Figure 2. Nokia FCC and RET components



Packet retransmission occurs only when packets are lost and only on those connections where the loss occurred. In addition, only the lost packet is retransmitted. This approach to packet loss recovery requires a negligible increment in bandwidth above the regular video stream bit rate, which makes it an ideal solution for IPTV distribution over DSL connections. The FCC/RET solution supports MPEG 2, MPEG 4, H.264 (AVC) and H.265 (HEVC) encoded video streams, as well as video profiles for Picture in Picture, Standard Definition (SD) , High Definition (HD), and Ultra High Definition (UHD) 4K.

Source: Application Note, "Enhanced TV services delivery", *available at* http://resources.alcatel-lucent.com/?cid=186272.

88. As shown above and below, Nokia promotes the video capture and compression capabilities of the 7750 SR router and 7450 ESS switch products using brochures directed at its end customers. Nokia also hosts a website dedicated to "IP Video" that contains brochures, whitepapers, eBooks, and blog entries related to Nokia's Velocix and other IP video solutions. This content contains detailed specifications for the networking equipment, as well as

instructions for configuring these components to operate in a particular way, including to use the H.264 compression capabilities, all of which is intended to induce Nokia's customers to use the 7750 SR router and 7450 ESS switch products in compliance with, among other things, the H.264 standard.

NOKIA

Portfolio Services Industries Innovation Support & training News & events

Solutions

IP Video

Discover our IP Video innovations

Our products and solutions draw on our Bell Labs innovations and proven expertise in IP and video network transformation. We have earned multiple awards for our service provider content delivery network (CDN) and Cloud DVR. And we are market leaders in both domains.

We are open to continuous innovation from industry-leading partners. Our partnerships help us build best-of-breed IP video platforms that work the way you need them to.

Products

Velocix Broadcast Optimizer

Explore our latest launches >

Send me the latest news and updates >

Contact sales >

Share

PRINT

The introduction of High Definition TV and multiple simultaneous video streams per home raise new challenges for IPTV service providers and cable operators. End users may suffer a degraded quality of experience if no specific action is taken. Visual distortions may occur frequently and the time to switch channels may increase to an unacceptable four to five seconds. In addition to the risk of losing customers, these problems increase the number of calls to customer support centers and the associated costs. The Velocix Broadcast Optimizer minimizes the time to switch channels and prevents visual distortions, providing a superior quality of experience for end users. This product suite operates with a wide range of the IPTV middleware platforms available in the market.

Related Materials

Application Notes: Enhanced IPTV services delivery - With fast channel change and video retransmission

Source: Nokia IP Video website, *available at* https://networks.nokia.com/solutions/ip-video

Source: Application Note, "Enhanced TV services delivery", *available at* http://resources.alcatel-lucent.com/?cid=186272.

89. These and other Nokia products that support the H.264 standard infringe at least one claim in each of Apple's H.264 Patents, as shown below. The claims presented below are illustrative and exemplary and by no means constitute the total set of claims Apple intends to assert, nor show every conceivable explanation of how the Nokia H.264 Accused Products infringe the claims of the Apple H.264 Patents.

A. Nokia's Infringement of the '584 Apple H.264 Patent.

90. By way of example, and as shown below, the Nokia H.264 Accused Products infringe at least claim 10 of the '584 Patent because they are compliant with the relevant portions of the H.264 Standard. For example, the Nokia H.264 Accused Products comprise a decoder.

As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to Annex A.1, Annex C, and Annex C.4.[12]

A.1 Requirements on video decoder capability

Capabilities of video decoders conforming to this Recommendation | International Standard are specified in terms of the ability to decode video streams conforming to the constraints of profiles and levels specified in this annex. For each such profile, the level supported for that profile shall also be expressed.

H.264, Annex A.1.

Hypothetical reference decoder

(This annex forms an integral part of this Recommendation | International Standard.)

This annex specifies the hypothetical reference decoder (HRD) and its use to check bitstream and decoder conformance.

(Annex C).

C.4 Decoder conformance

A decoder conforming to this Recommendation | International Standard fulfils the following requirements.

H.264, Annex C.4.

91. The decoder of the Nokia H.264 Accused Products further comprises a storage for a first video picture a second video picture, and a third video picture. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to Annex C.2.4, §§ 0.2, 3, and 8.4.

The marking and storage of the current decoded picture is specified as follows:

– If the current picture is a reference picture, the marking and storage process for reference pictures as specified in clause C.2.4.1 is invoked.

– Otherwise (the current picture is a non-reference picture), the storage process for non-reference pictures as specified in clause C.2.4.2 is invoked.

H.264, Annex C.2.4.

[12] Although the citations are to the current version of the H.264 standard, dated October 2016, the cited functionality for each claim of infringement has been included in versions of the H.264 standard since at least 2010.

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This Recommendation | International Standard was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, internet streaming, and communication. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

H.264, Section 0.2.

3.28 **coded picture buffer (CPB)**: A first-in first-out buffer containing *access units* in *decoding order* specified in the *hypothetical reference decoder* in Annex C.

3.1 **access unit**: A set of *NAL units* that are consecutive in *decoding order* and contain exactly one *primary coded picture*. In addition to the *primary coded picture*, an access unit may also contain one or more *redundant coded pictures*, one *auxiliary coded picture*, or other *NAL units* not containing *slices* or *slice data partitions* of a *coded picture*. The decoding of an access unit always results in a *decoded picture*.

3.14 **bitstream**: A sequence of bits that forms the representation of *coded pictures* and associated data forming one or more *coded video sequences*. Bitstream is a collective term used to refer either to a *NAL unit stream* or a *byte stream*.

3.40 **decoded picture buffer (DPB)**: A buffer holding *decoded pictures* for reference, output reordering, or output delay specified for the *hypothetical reference decoder* in Annex C.

3.44 **decoding process**: The process specified in this Recommendation | International Standard that reads a *bitstream* and derives *decoded pictures* from it.

H.264, Section 3.

The HRD contains a coded picture buffer (CPB), an instantaneous decoding process, a decoded picture buffer (DPB), and output cropping as shown in Figure C-2.

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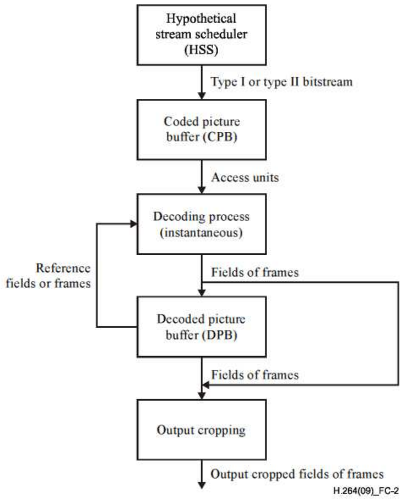

Figure C-2 – HRD buffer model

H.264, Section 8.4.

92. The decoder of the Nokia H.264 Accused Products further comprises at least one processor. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to H.264 Summary and § 0.2.

Summary

Recommendation ITU-T H.264 | International Standard ISO/IEC 14496-10 represents an evolution of the existing video coding standards (ITU-T H.261, ITU-T H.262, and ITU-T H.263) and it was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, Internet streaming, and communication. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

H.264, H.264 Summary.

0.2 Purpose

This clause does not form an integral part of this Recommendation | International Standard.

This Recommendation | International Standard was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, internet streaming, and communication. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

H.264, Section 0.2.

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93. The processor of the Nokia H.264 Accused Products further performs the step of computing a particular value that is based on a first order difference value and a second order difference value. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 3 and 8.4.1.2.3.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.65 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.66 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.75 **list 0 (list 1) motion vector**: A *motion vector* associated with a *reference index* pointing into *reference picture list 0* (*list 1*).

3.76 **list 0 (list 1) prediction**: *Inter prediction* of the content of a *slice* using a *reference index* pointing into *reference picture list 0* (*list 1*).

3.89 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.101 **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.109 **prediction**: An embodiment of the *prediction process*.

3.110 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

3.112 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.125 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.126 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P, B,* or *SP slice*. For the *decoding process* of a *P* or *SP slice,* there is one reference picture list. For the *decoding process* of a *B slice*, there are two reference picture lists.

3.127 **reference picture list 0**: A *reference picture list* used for *inter prediction* of a *P*, *B*, or *SP slice*. All *inter prediction* used for *P* and *SP slices* uses reference picture list 0. Reference picture list 0 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 1*.

3.128 **reference picture list 1**: A *reference picture list* used for *inter prediction* of a *B slice*. Reference picture list 1 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 0*.

3.129 **reference picture marking**: Specifies, in the bitstream, how the *decoded pictures* are marked for *inter prediction*.

H.264, Section 3.

8.4.1.2.3 Derivation process for temporal direct luma motion vector and reference index prediction mode

This process is invoked when direct_spatial_mv_pred_flag is equal to 0 and any of the following conditions are true:

– mb_type is equal to B_Skip,

– mb_type is equal to B_Direct_16x16,

– sub_mb_type[mbPartIdx] is equal to B_Direct_8x8.

Inputs to this process are mbPartIdx and subMbPartIdx.

– Otherwise, the motion vectors mvL0, mvL1 are derived as scaled versions of the motion vector mvCol of the co-located sub-macroblock partition as specified below (see Figure 8-2).

$$tx = (16\,384 + Abs(td / 2)) / td \quad (8\text{-}197)$$

$$DistScaleFactor = Clip3(-1024, 1023, (tb * tx + 32) >> 6) \quad (8\text{-}198)$$

$$mvL0 = (DistScaleFactor * mvCol + 128) >> 8 \quad (8\text{-}199)$$

$$mvL1 = mvL0 - mvCol \quad (8\text{-}200)$$

where tb and td are derived as:

$$tb = Clip3(-128, 127, DiffPicOrderCnt(currPicOrField, pic0)) \quad (8\text{-}201)$$

$$td = Clip3(-128, 127, DiffPicOrderCnt(pic1, pic0)) \quad (8\text{-}202)$$

H.264, Section 8.4.1.2.3.

94. The processor of the Nokia H.264 Accused Products further computes a particular value that is based on a first order difference value and a second order difference value wherein the first order difference value is representative of a difference between an order value for the third video picture and an order value for the first video picture. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 8.2.1, 8.4.1.2.3, and Figure 8-2.

8.2.1 Decoding process for picture order count

Outputs of this process are TopFieldOrderCnt (if applicable) and BottomFieldOrderCnt (if applicable).

Picture order counts are used to determine initial picture orderings for reference pictures in the decoding of B slices (see clauses 8.2.4.2.3 and 8.2.4.2.4), to determine co-located pictures (see clause 8.4.1.2.1) for deriving motion parameters in temporal or spatial direct mode, to represent picture order differences between frames or fields for motion vector derivation in temporal direct mode (see clause 8.4.1.2.3), for implicit mode weighted prediction in B slices (see clause 8.4.2.3.2), and for decoder conformance checking (see clause C.4).

The function PicOrderCnt(picX) is specified as follows:

```
if( picX is a frame or a complementary field pair )
   PicOrderCnt( picX ) = Min( TopFieldOrderCnt, BottomFieldOrderCnt ) of the frame or complementary field
pair picX
else if( picX is a top field )
   PicOrderCnt( picX ) = TopFieldOrderCnt of field picX                                   (8-1)
else if( picX is a bottom field )
   PicOrderCnt( picX ) = BottomFieldOrderCnt of field picX
```

Then DiffPicOrderCnt(picA, picB) is specified as follows:

DiffPicOrderCnt(picA, picB) = PicOrderCnt(picA) − PicOrderCnt(picB) (8-2)

(Section 8.2.1).

Otherwise, the motion vectors mvL0, mvL1 are derived as scaled versions of the motion vector mvCol of the co-located sub-macroblock partition as specified below (see Figure 8-2).

tx = (16 384 + Abs(td / 2)) / td (8-197)

DistScaleFactor = Clip3(-1024, 1023, (tb * tx + 32) >> 6) (8-198)

mvL0 = (DistScaleFactor * mvCol + 128) >> 8 (8-199)

mvL1 = mvL0 − mvCol (8-200)

where tb and td are derived as:

tb = Clip3(-128, 127, DiffPicOrderCnt(currPicOrField, pic0)) (8-201)

td = Clip3(-128, 127, DiffPicOrderCnt(pic1, pic0)) (8-202)

H.264, Section 8.4.1.2.3.

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Figure 8-2 illustrates the temporal direct-mode motion vector inference when the current picture is temporally between the reference picture from reference picture list 0 and the reference picture from reference picture list 1.

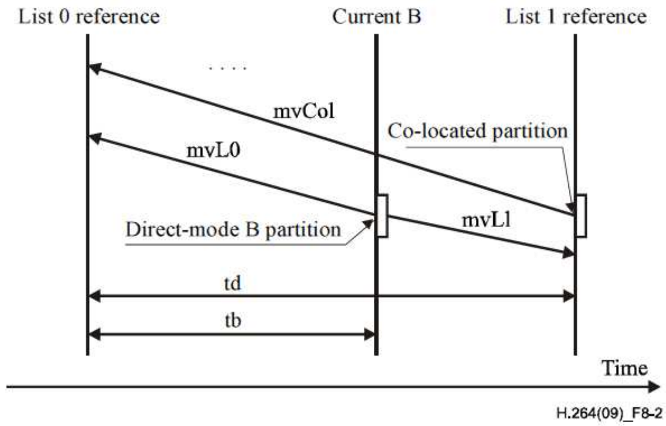

Figure 8-2 – Example for temporal direct-mode motion vector inference (informative)

H.264, Fig. 8-2.

95. The processor of the Nokia H.264 Accused Products further computes a particular value that is based on a first order difference value and a second order difference value wherein the second order difference value is representative of a difference between an order value for the second video picture and the order value of the first video picture. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 8.4.1.2.3 and Fig. 8-2.

where tb and td are derived as:

tb = Clip3(-128, 127, DiffPicOrderCnt(currPicOrField, pic0)) (8-201)

td = Clip3(-128, 127, DiffPicOrderCnt(pic1, pic0)) (8-202)

H.264, Section 8.4.1.2.3.

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Figure 8-2 illustrates the temporal direct-mode motion vector inference when the current picture is temporally between the reference picture from reference picture list 0 and the reference picture from reference picture list 1.

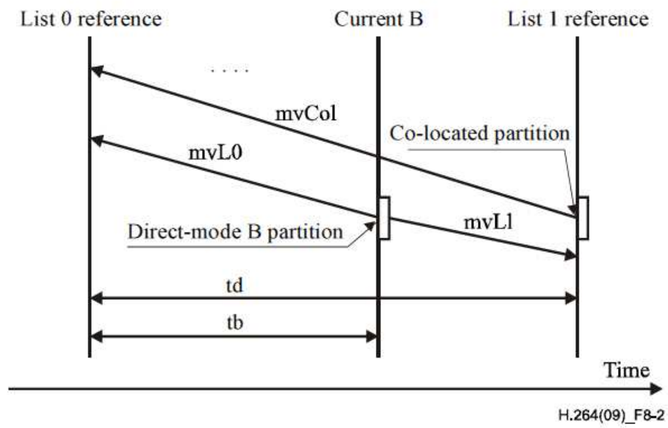

Figure 8-2 – Example for temporal direct-mode motion vector inference (informative)

H.264, Fig. 8-2.

96. The processor of the Nokia H.264 Accused Products further computes a particular value that is based on a first order difference value and a second order difference value wherein an order value for the particular video picture is representative of a position for the particular video picture in a sequence of video pictures. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 3 and 8.2.

3.101 **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

H.264, Section 3.

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8.2 Slice decoding process

8.2.1 Decoding process for picture order count

Outputs of this process are TopFieldOrderCnt (if applicable) and BottomFieldOrderCnt (if applicable).

Picture order counts are used to determine initial picture orderings for reference pictures in the decoding of B slices (see clauses 8.2.4.2.3 and 8.2.4.2.4), to determine co-located pictures (see clause 8.4.1.2.1) for deriving motion parameters in temporal or spatial direct mode, to represent picture order differences between frames or fields for motion vector derivation in temporal direct mode (see clause 8.4.1.2.3), for implicit mode weighted prediction in B slices (see clause 8.4.2.3.2), and for decoder conformance checking (see clause C.4).

Picture order count information is derived for every frame, field (whether decoded from a coded field or as a part of a decoded frame), or complementary field pair as follows:

– Each coded frame is associated with two picture order counts, called TopFieldOrderCnt and BottomFieldOrderCnt for its top field and bottom field, respectively.

– Each coded field is associated with a picture order count, called TopFieldOrderCnt for a coded top field and BottomFieldOrderCnt for a bottom field.

– Each complementary field pair is associated with two picture order counts, which are the TopFieldOrderCnt for its coded top field and the BottomFieldOrderCnt for its coded bottom field, respectively.

TopFieldOrderCnt and BottomFieldOrderCnt indicate the picture order of the corresponding top field or bottom field relative to the first output field of the previous IDR picture or the previous reference picture including a memory_management_control_operation equal to 5 in decoding order.

H.264, Section 8.2.

97. The processor of the Nokia H.264 Accused Products further performs the step of computing a motion vector for the second video picture based on the particular value and a motion vector for the third video picture. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to § 3 and Figure 8-2.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.65 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.66 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.75 **list 0 (list 1) motion vector**: A *motion vector* associated with a *reference index* pointing into *reference picture list 0* (*list 1*).

3.76 **list 0 (list 1) prediction**: *Inter prediction* of the content of a *slice* using a *reference index* pointing into *reference picture list 0* (*list 1*).

3.89 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

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3.109 **prediction**: An embodiment of the *prediction process*.

3.110 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

3.112 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.125 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.126 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P*, *B*, or *SP slice*. For the *decoding process* of a *P* or *SP slice*, there is one reference picture list. For the *decoding process* of a *B slice*, there are two reference picture lists.

3.127 **reference picture list 0**: A *reference picture list* used for *inter prediction* of a *P*, *B*, or *SP slice*. All *inter prediction* used for *P* and *SP slices* uses reference picture list 0. Reference picture list 0 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 1*.

3.128 **reference picture list 1**: A *reference picture list* used for *inter prediction* of a *B slice*. Reference picture list 1 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 0*.

3.129 **reference picture marking**: Specifies, in the bitstream, how the *decoded pictures* are marked for *inter prediction*.

H.264, Section 3.

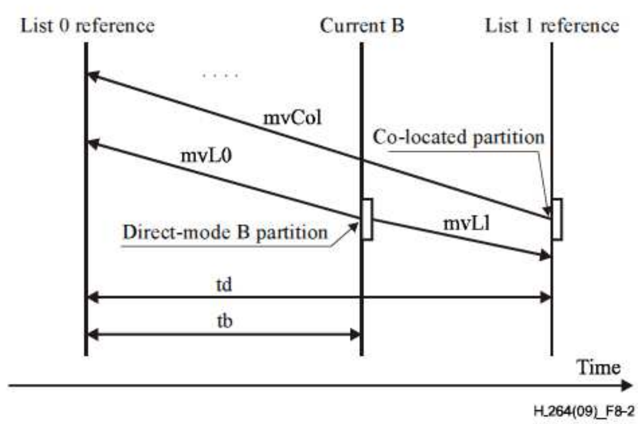

Figure 8-2 – Example for temporal direct-mode motion vector inference (informative)

H.264, Fig. 8-2.

98. The processor of the Nokia H.264 Accused Products further performs the step of computing another motion vector for the second video picture based on the motion vector for the

third video picture. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to Fig. 8-2 and § 8.4.1.2.3.

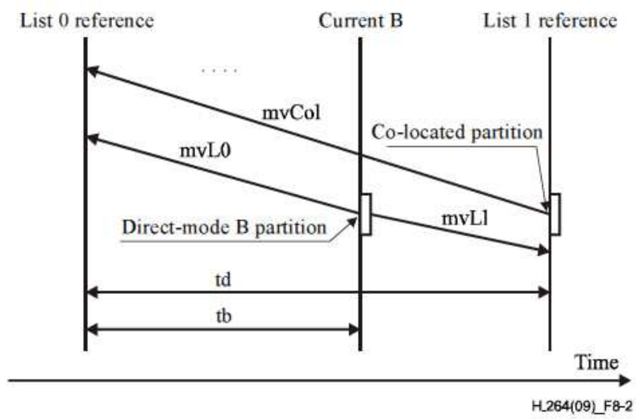

Figure 8-2 – Example for temporal direct-mode motion vector inference (informative)

H.264, Fig. 8-2.

Otherwise, the motion vectors mvL0, mvL1 are derived as scaled versions of the motion vector mvCol of the co-located sub-macroblock partition as specified below (see Figure 8-2).

$$tx = (16\,384 + Abs(td / 2)) / td \quad (8\text{-}197)$$

$$DistScaleFactor = Clip3(-1024, 1023, (tb * tx + 32) >> 6) \quad (8\text{-}198)$$

$$mvL0 = (DistScaleFactor * mvCol + 128) >> 8 \quad (8\text{-}199)$$

$$mvL1 = mvL0 - mvCol \quad (8\text{-}200)$$

H.264, Section 8.4.1.2.3.

99. The processor of the Nokia H.264 Accused Products further performs the step of decoding at least one video picture by using the computed motion vectors. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 3, 8.2.1, 8.4 and Figure 8-2.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.65 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.66 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

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3.89 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.109 **prediction**: An embodiment of the *prediction process*.

3.110 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

3.112 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.125 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.126 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P*, *B*, or *SP slice*. For the *decoding process* of a *P* or *SP slice*, there is one reference picture list. For the *decoding process* of a *B slice*, there are two reference picture lists.

H.264, Section 3.

8.2.1 Decoding process for picture order count

Outputs of this process are TopFieldOrderCnt (if applicable) and BottomFieldOrderCnt (if applicable).

Picture order counts are used to determine initial picture orderings for reference pictures in the decoding of B slices (see clauses 8.2.4.2.3 and 8.2.4.2.4), to determine co-located pictures (see clause 8.4.1.2.1) for deriving motion parameters in temporal or spatial direct mode, to represent picture order differences between frames or fields for motion vector derivation in temporal direct mode (see clause 8.4.1.2.3), for implicit mode weighted prediction in B slices (see clause 8.4.2.3.2), and for decoder conformance checking (see clause C.4).

H.264, Section 8.2.1.

8.4 Inter prediction process

This process is invoked when decoding P and B macroblock types.

Outputs of this process are Inter prediction samples for the current macroblock that are a 16x16 array $pred_L$ of luma samples and when ChromaArrayType is not equal to 0 two (MbWidthC)x(MbHeightC) arrays $pred_{Cb}$ and $pred_{Cr}$ of chroma samples, one for each of the chroma components Cb and Cr.

The Inter prediction process for a macroblock partition mbPartIdx and a sub-macroblock partition subMbPartIdx consists of the following ordered steps:

1. The derivation process for motion vector components and reference indices as specified in clause 8.4.1 is invoked.

   Inputs to this process are:

   – a macroblock partition mbPartIdx,

   – a sub-macroblock partition subMbPartIdx.

Outputs of this process are:

– luma motion vectors mvL0 and mvL1 and when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1

– reference indices refIdxL0 and refIdxL1

– prediction list utilization flags predFlagL0 and predFlagL1

– the sub-macroblock partition motion vector count subMvCnt.

H.264, Section 8.4.

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Figure 8-2 illustrates the temporal direct-mode motion vector inference when the current picture is temporally between the reference picture from reference picture list 0 and the reference picture from reference picture list 1.

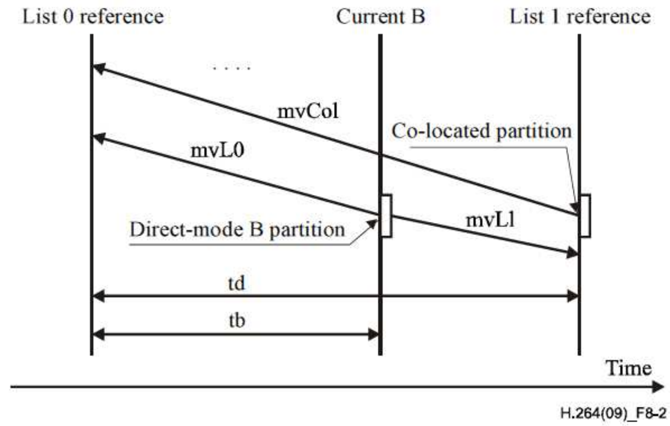

Figure 8-2 – Example for temporal direct-mode motion vector inference (informative)

H.264, Fig. 8-2.

100. Thus, as described above, the Nokia H.264 Accused Products infringe one or more claims of the ’584 Patent, including claim 10.

B. Nokia’s Infringement of the ’026 Apple H.264 Patent.

101. By way of example, and as shown below, the Nokia H.264 Accused Products infringe at least claim 8 of the ’026 Patent because they are compliant with the relevant portions of the H.264 Standard. For example, the Nokia H.264 Accused Products comprise a decoder. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to Annex A.1, Annex C, and Annex C.4.

A.1 Requirements on video decoder capability

Capabilities of video decoders conforming to this Recommendation | International Standard are specified in terms of the ability to decode video streams conforming to the constraints of profiles and levels specified in this annex. For each such profile, the level supported for that profile shall also be expressed.

H.264, Annex A.1

Hypothetical reference decoder

(This annex forms an integral part of this Recommendation | International Standard.)

This annex specifies the hypothetical reference decoder (HRD) and its use to check bitstream and decoder conformance.

H.264, Annex C.

C.4 Decoder conformance

A decoder conforming to this Recommendation | International Standard fulfils the following requirements.

H.264, Annex C.4.

102. The Nokia H.264 Accused Products further comprise a module that receives a bitstream comprising an encoded first video picture, and an encoded second video picture. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 0.2, 3, and 8.4.

This Recommendation | International Standard was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, internet streaming, and communication. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

H.264, Section 0.2.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.14 **bitstream**: A sequence of bits that forms the representation of *coded pictures* and associated data forming one or more *coded video sequences*. Bitstream is a collective term used to refer either to a *NAL unit stream* or a *byte stream*.

3.21 **byte stream**: An encapsulation of a *NAL unit stream* containing *start code prefixes* and *NAL units* as specified in Annex B.

3.28 **coded picture buffer (CPB)**: A first-in first-out buffer containing *access units* in *decoding order* specified in the *hypothetical reference decoder* in Annex C.

3.40 **decoded picture buffer (DPB)**: A buffer holding *decoded pictures* for reference, output reordering, or output delay specified for the *hypothetical reference decoder* in Annex C.

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3.44 **decoding process**: The process specified in this Recommendation | International Standard that reads a *bitstream* and derives *decoded pictures* from it.

H.264, Section 3.

The HRD contains a coded picture buffer (CPB), an instantaneous decoding process, a decoded picture buffer (DPB), and output cropping as shown in Figure C-2.

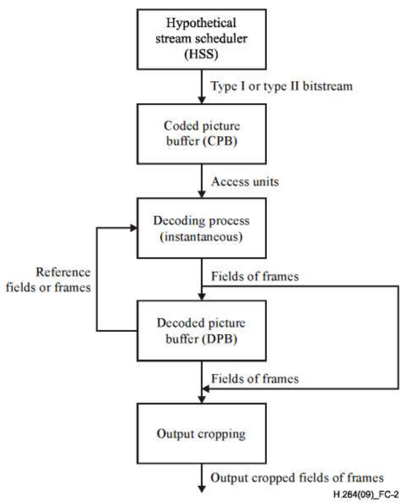

Figure C-2 – HRD buffer model

H.264, Section 8.4.

103. The bitstream received by module of the Nokia H.264 Accused Products further includes an encoded order value relating the second video picture to the first video picture. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 3, 8.2.1, 8.4.1.2.3, and Figure 8-2.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.65 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.66 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.75 **list 0 (list 1) motion vector**: A *motion vector* associated with a *reference index* pointing into *reference picture list 0* (*list 1*).

3.76 **list 0 (list 1) prediction**: *Inter prediction* of the content of a *slice* using a *reference index* pointing into *reference picture list 0* (*list 1*).

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3.89 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.101 **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.109 **prediction**: An embodiment of the *prediction process*.

3.110 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

3.112 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.125 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.126 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P, B,* or *SP slice*. For the *decoding process* of a *P* or *SP slice*, there is one reference picture list. For the *decoding process* of a *B slice*, there are two reference picture lists.

3.127 **reference picture list 0**: A *reference picture list* used for *inter prediction* of a *P*, *B*, or *SP slice*. All *inter prediction* used for *P* and *SP slices* uses reference picture list 0. Reference picture list 0 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 1*.

3.128 **reference picture list 1**: A *reference picture list* used for *inter prediction* of a *B slice*. Reference picture list 1 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 0*.

3.129 **reference picture marking**: Specifies, in the bitstream, how the *decoded pictures* are marked for *inter prediction*.

H.264, Section 3.

The function PicOrderCnt(picX) is specified as follows:

```
if( picX is a frame or a complementary field pair )
   PicOrderCnt( picX ) = Min( TopFieldOrderCnt, BottomFieldOrderCnt ) of the frame or complementary field
pair picX
else if( picX is a top field )
   PicOrderCnt( picX ) = TopFieldOrderCnt of field picX                                    (8-1)
else if( picX is a bottom field )
   PicOrderCnt( picX ) = BottomFieldOrderCnt of field picX
```

Then DiffPicOrderCnt(picA, picB) is specified as follows:

DiffPicOrderCnt(picA, picB) = PicOrderCnt(picA) − PicOrderCnt(picB) (8-2)

H.264, Section 8.2.1.

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8.4.1.2.3 Derivation process for temporal direct luma motion vector and reference index prediction mode

This process is invoked when direct_spatial_mv_pred_flag is equal to 0 and any of the following conditions are true:

– mb_type is equal to B_Skip,

– mb_type is equal to B_Direct_16x16,

– sub_mb_type[mbPartIdx] is equal to B_Direct_8x8.

Inputs to this process are mbPartIdx and subMbPartIdx.

– Otherwise, the motion vectors mvL0, mvL1 are derived as scaled versions of the motion vector mvCol of the co-located sub-macroblock partition as specified below (see Figure 8-2).

tx = (16 384 + Abs(td / 2)) / td (8-197)

DistScaleFactor = Clip3(-1024, 1023, (tb * tx + 32) >> 6) (8-198)

mvL0 = (DistScaleFactor * mvCol + 128) >> 8 (8-199)

mvL1 = mvL0 − mvCol (8-200)

where tb and td are derived as:

tb = Clip3(-128, 127, DiffPicOrderCnt(currPicOrField, pic0)) (8-201)

td = Clip3(-128, 127, DiffPicOrderCnt(pic1, pic0)) (8-202)

H.264, Section 8.4.1.2.3.

Figure 8-2 illustrates the temporal direct-mode motion vector inference when the current picture is temporally between the reference picture from reference picture list 0 and the reference picture from reference picture list 1.

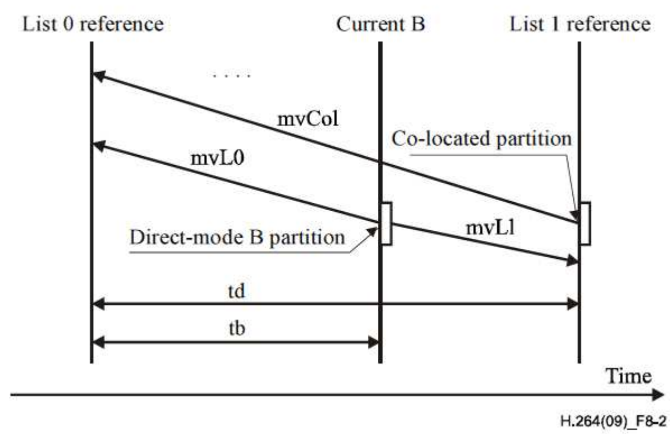

Figure 8-2 – Example for temporal direct-mode motion vector inference (informative)

H.264, Fig. 8-2.

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104. The bitstream received by module of the Nokia H.264 Accused Products further includes the order value encoded in a slice header that is associated with the second video picture. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 3, 7.4.2.1.1, and 8.2.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.65 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.66 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.75 **list 0 (list 1) motion vector**: A *motion vector* associated with a *reference index* pointing into *reference picture list 0* (*list 1*).

3.76 **list 0 (list 1) prediction**: *Inter prediction* of the content of a *slice* using a *reference index* pointing into *reference picture list 0* (*list 1*).

3.89 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.101 **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.109 **prediction**: An embodiment of the *prediction process*.

3.110 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

3.112 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.125 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.126 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P, B,* or *SP slice*. For the *decoding process* of a *P* or *SP slice,* there is one reference picture list. For the *decoding process* of a *B slice*, there are two reference picture lists.

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3.127 **reference picture list 0**: A *reference picture list* used for *inter prediction* of a *P*, *B*, or *SP slice*. All *inter prediction* used for *P* and *SP slices* uses reference picture list 0. Reference picture list 0 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 1*.

3.128 **reference picture list 1**: A *reference picture list* used for *inter prediction* of a *B slice*. Reference picture list 1 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 0*.

3.129 **reference picture marking**: Specifies, in the bitstream, how the *decoded pictures* are marked for *inter prediction*.

3.140 **slice**: An integer number of *macroblocks* or *macroblock pairs* ordered consecutively in the *raster scan* within a particular *slice group*. For the *primary coded picture*, the division of each *slice group* into slices is a *partitioning*. Although a slice contains *macroblocks* or *macroblock pairs* that are consecutive in the *raster scan* within a *slice group*, these *macroblocks* or *macroblock pairs* are not necessarily consecutive in the *raster scan* within the *picture*. The *macroblock addresses* are derived from the first *macroblock address* in a slice (as represented in the *slice header*) and the *macroblock to slice group map*, and, when a *picture* is coded using three separate colour planes, a colour plane identifier.

3.145 **slice header**: A part of a coded *slice* containing the data elements pertaining to the first or all *macroblocks* represented in the *slice*.

H.264, Section 3.

log2_max_pic_order_cnt_lsb_minus4 specifies the value of the variable MaxPicOrderCntLsb that is used in the decoding process for picture order count as specified in clause 8.2.1 as follows:

$$\text{MaxPicOrderCntLsb} = 2^{(\text{log2\_max\_pic\_order\_cnt\_lsb\_minus4} + 4)} \quad (7\text{-}11)$$

The value of log2_max_pic_order_cnt_lsb_minus4 shall be in the range of 0 to 12, inclusive.

H.264, Section 7.4.2.1.1.

8.2 Slice decoding process

8.2.1 Decoding process for picture order count

Outputs of this process are TopFieldOrderCnt (if applicable) and BottomFieldOrderCnt (if applicable).

Picture order counts are used to determine initial picture orderings for reference pictures in the decoding of B slices (see clauses 8.2.4.2.3 and 8.2.4.2.4), to determine co-located pictures (see clause 8.4.1.2.1) for deriving motion parameters in temporal or spatial direct mode, to represent picture order differences between frames or fields for motion vector derivation in temporal direct mode (see clause 8.4.1.2.3), for implicit mode weighted prediction in B slices (see clause 8.4.2.3.2), and for decoder conformance checking (see clause C.4).

TopFieldOrderCnt and BottomFieldOrderCnt are derived by invoking one of the decoding processes for picture order count type 0, 1, and 2 in clauses 8.2.1.1, 8.2.1.2, and 8.2.1.3, respectively. When the current picture includes a memory_management_control_operation equal to 5, after the decoding of the current picture, tempPicOrderCnt is set equal to PicOrderCnt(CurrPic), TopFieldOrderCnt of the current picture (if any) is set equal to TopFieldOrderCnt − tempPicOrderCnt, and BottomFieldOrderCnt of the current picture (if any) is set equal to BottomFieldOrderCnt − tempPicOrderCnt.

H.264, Section 8.2.

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105. The Nokia H.264 Accused Products further comprise a module that calculates a first motion vector for decoding the second video picture by using said order value. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 3, 8.2.1, 8.4, and 8.4.1.2.3.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.65 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.66 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.75 **list 0 (list 1) motion vector**: A *motion vector* associated with a *reference index* pointing into *reference picture list 0* (*list 1*).

3.76 **list 0 (list 1) prediction**: *Inter prediction* of the content of a *slice* using a *reference index* pointing into *reference picture list 0* (*list 1*).

3.89 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.101 **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.109 **prediction**: An embodiment of the *prediction process*.

3.110 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

3.112 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.125 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.126 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P, B,* or *SP slice*. For the *decoding process* of a *P* or *SP slice,* there is one reference picture list. For the *decoding process* of a *B slice*, there are two reference picture lists.

3.127 **reference picture list 0**: A *reference picture list* used for *inter prediction* of a *P*, *B*, or *SP slice*. All *inter prediction* used for *P* and *SP slices* uses reference picture list 0. Reference picture list 0 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 1*.

3.128 **reference picture list 1**: A *reference picture list* used for *inter prediction* of a *B slice*. Reference picture list 1 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 0*.

3.129 **reference picture marking**: Specifies, in the bitstream, how the *decoded pictures* are marked for *inter prediction*.

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H.264, Section 3.

8.2.1 Decoding process for picture order count

Outputs of this process are TopFieldOrderCnt (if applicable) and BottomFieldOrderCnt (if applicable).

Picture order counts are used to determine initial picture orderings for reference pictures in the decoding of B slices (see clauses 8.2.4.2.3 and 8.2.4.2.4), to determine co-located pictures (see clause 8.4.1.2.1) for deriving motion parameters in temporal or spatial direct mode, to represent picture order differences between frames or fields for motion vector derivation in temporal direct mode (see clause 8.4.1.2.3), for implicit mode weighted prediction in B slices (see clause 8.4.2.3.2), and for decoder conformance checking (see clause C.4).

H.264, Section 8.2.1.

8.4 Inter prediction process

This process is invoked when decoding P and B macroblock types.

Outputs of this process are Inter prediction samples for the current macroblock that are a 16x16 array $pred_L$ of luma samples and when ChromaArrayType is not equal to 0 two (MbWidthC)x(MbHeightC) arrays $pred_{Cb}$ and $pred_{Cr}$ of chroma samples, one for each of the chroma components Cb and Cr.

The Inter prediction process for a macroblock partition mbPartIdx and a sub-macroblock partition subMbPartIdx consists of the following ordered steps:

1. The derivation process for motion vector components and reference indices as specified in clause 8.4.1 is invoked.

   Inputs to this process are:

   – a macroblock partition mbPartIdx,

   – a sub-macroblock partition subMbPartIdx.

Outputs of this process are:

– luma motion vectors mvL0 and mvL1 and when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1

– reference indices refIdxL0 and refIdxL1

– prediction list utilization flags predFlagL0 and predFlagL1

– the sub-macroblock partition motion vector count subMvCnt.

H.264, Section 8.4.

8.4.1.2.3 Derivation process for temporal direct luma motion vector and reference index prediction mode

This process is invoked when direct_spatial_mv_pred_flag is equal to 0 and any of the following conditions are true:

– mb_type is equal to B_Skip,

– mb_type is equal to B_Direct_16x16,

– sub_mb_type[mbPartIdx] is equal to B_Direct_8x8.

Inputs to this process are mbPartIdx and subMbPartIdx.

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– Otherwise, the motion vectors mvL0, mvL1 are derived as scaled versions of the motion vector mvCol of the co-located sub-macroblock partition as specified below (see Figure 8-2).

$$tx = (16\,384 + Abs(td / 2)) / td \quad (8\text{-}197)$$

$$DistScaleFactor = Clip3(-1024, 1023, (tb * tx + 32) >> 6) \quad (8\text{-}198)$$

$$mvL0 = (DistScaleFactor * mvCol + 128) >> 8 \quad (8\text{-}199)$$

$$mvL1 = mvL0 - mvCol \quad (8\text{-}200)$$

where tb and td are derived as:

$$tb = Clip3(-128, 127, DiffPicOrderCnt(currPicOrField, pic0)) \quad (8\text{-}201)$$

$$td = Clip3(-128, 127, DiffPicOrderCnt(pic1, pic0)) \quad (8\text{-}202)$$

H.264, Section 8.4.1.2.3.

106. Thus, as described above, the Nokia H.264 Accused Products infringe one or more claims of the ’026 Patent, including claim 8.

C. Nokia’s Infringement of the ’339 Apple H.264 Patent.

107. By way of example, and as shown below, the Nokia H.264 Accused Products infringe at least claim 10 of the ’339 Patent because they are compliant with the relevant portions of the H.264 Standard. For example, the Nokia H.264 Accused Products comprise a decoder for decoding a plurality of video pictures, the decoder to execute a process. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to Annex A.1, Annex C, Annex C.4, H.264 Summary, and § 0.2.

A.1 Requirements on video decoder capability

Capabilities of video decoders conforming to this Recommendation | International Standard are specified in terms of the ability to decode video streams conforming to the constraints of profiles and levels specified in this annex. For each such profile, the level supported for that profile shall also be expressed.

H.264, Annex A.1.

PUBLIC REDACTED VERSION OF DOCUMENT FILED UNDER SEAL

Hypothetical reference decoder

(This annex forms an integral part of this Recommendation | International Standard.)

This annex specifies the hypothetical reference decoder (HRD) and its use to check bitstream and decoder conformance.

H.264, Annex C.

C.4 Decoder conformance

A decoder conforming to this Recommendation | International Standard fulfils the following requirements.

H.264, Annex C.4.

Summary

Recommendation ITU-T H.264 | International Standard ISO/IEC 14496-10 represents an evolution of the existing video coding standards (ITU-T H.261, ITU-T H.262, and ITU-T H.263) and it was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, Internet streaming, and communication. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

H.264, Summary.

0.2 Purpose

This clause does not form an integral part of this Recommendation | International Standard.

This Recommendation | International Standard was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, internet streaming, and communication. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

H.264, Section 0.2.

108. The decoder of the Nokia H.264 Accused Products further executes a process comprising receiving an encoded video picture comprising a plurality of identical instances of an encoded order value. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 0.2, 3, and 8.4.

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This Recommendation | International Standard was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, internet streaming, and communication. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

H.264, Section 0.2.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.14 **bitstream**: A sequence of bits that forms the representation of *coded pictures* and associated data forming one or more *coded video sequences*. Bitstream is a collective term used to refer either to a *NAL unit stream* or a *byte stream*.

3.21 **byte stream**: An encapsulation of a *NAL unit stream* containing *start code prefixes* and *NAL units* as specified in Annex B.

3.28 **coded picture buffer (CPB)**: A first-in first-out buffer containing *access units* in *decoding order* specified in the *hypothetical reference decoder* in Annex C.

3.40 **decoded picture buffer (DPB)**: A buffer holding *decoded pictures* for reference, output reordering, or output delay specified for the *hypothetical reference decoder* in Annex C.

3.44 **decoding process**: The process specified in this Recommendation | International Standard that reads a *bitstream* and derives *decoded pictures* from it.

H.264, Section 3.

The HRD contains a coded picture buffer (CPB), an instantaneous decoding process, a decoded picture buffer (DPB), and output cropping as shown in Figure C-2.

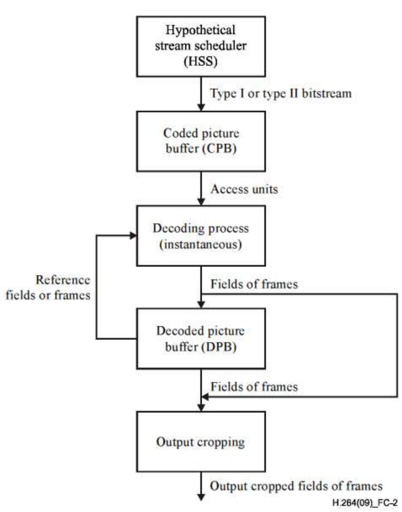

Figure C-2 – HRD buffer model

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H.264, Section 8.4.

109. The decoder of the Nokia H.264 Accused Products further executes a process comprising receiving an encoded video picture comprising a plurality of identical instances of an encoded order value, the order value representative of a position of the video picture with reference to a nearby video picture in a sequential order of video pictures. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 3, **7.4.2.1.1**., 8.2, 8.4.1.2.3, and Figure 8-2.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.65 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.66 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.75 **list 0 (list 1) motion vector**: A *motion vector* associated with a *reference index* pointing into *reference picture list 0* (*list 1*).

3.76 **list 0 (list 1) prediction**: *Inter prediction* of the content of a *slice* using a *reference index* pointing into *reference picture list 0* (*list 1*).

3.89 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.101 **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.109 **prediction**: An embodiment of the *prediction process*.

3.110 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

3.112 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.125 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.126 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P*, *B*, or *SP slice*. For the *decoding process* of a *P* or *SP slice*, there is one reference picture list. For the *decoding process* of a *B slice*, there are two reference picture lists.

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3.127 **reference picture list 0**: A *reference picture list* used for *inter prediction* of a *P*, *B*, or *SP slice*. All *inter prediction* used for *P* and *SP slices* uses reference picture list 0. Reference picture list 0 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 1*.

3.128 **reference picture list 1**: A *reference picture list* used for *inter prediction* of a *B slice*. Reference picture list 1 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 0*.

3.129 **reference picture marking**: Specifies, in the bitstream, how the *decoded pictures* are marked for *inter prediction*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.140 **slice**: An integer number of *macroblocks* or *macroblock pairs* ordered consecutively in the *raster scan* within a particular *slice group*. For the *primary coded picture*, the division of each *slice group* into slices is a *partitioning*. Although a slice contains *macroblocks* or *macroblock pairs* that are consecutive in the *raster scan* within a *slice group*, these *macroblocks* or *macroblock pairs* are not necessarily consecutive in the *raster scan* within the *picture*. The *macroblock addresses* are derived from the first *macroblock address* in a slice (as represented in the *slice header*) and the *macroblock to slice group map*, and, when a *picture* is coded using three separate colour planes, a colour plane identifier.

3.145 **slice header**: A part of a coded *slice* containing the data elements pertaining to the first or all *macroblocks* represented in the *slice*.

H.264, Section 3.

log2_max_pic_order_cnt_lsb_minus4 specifies the value of the variable MaxPicOrderCntLsb that is used in the decoding process for picture order count as specified in clause 8.2.1 as follows:

$$\text{MaxPicOrderCntLsb} = 2^{(\text{log2\_max\_pic\_order\_cnt\_lsb\_minus4} + 4)} \quad (7\text{-}11)$$

The value of log2_max_pic_order_cnt_lsb_minus4 shall be in the range of 0 to 12, inclusive.

H.264, Section 7.4.2.1.1.

8.2 Slice decoding process

8.2.1 Decoding process for picture order count

Outputs of this process are TopFieldOrderCnt (if applicable) and BottomFieldOrderCnt (if applicable).

Picture order counts are used to determine initial picture orderings for reference pictures in the decoding of B slices (see clauses 8.2.4.2.3 and 8.2.4.2.4), to determine co-located pictures (see clause 8.4.1.2.1) for deriving motion parameters in temporal or spatial direct mode, to represent picture order differences between frames or fields for motion vector derivation in temporal direct mode (see clause 8.4.1.2.3), for implicit mode weighted prediction in B slices (see clause 8.4.2.3.2), and for decoder conformance checking (see clause C.4).

TopFieldOrderCnt and BottomFieldOrderCnt are derived by invoking one of the decoding processes for picture order count type 0, 1, and 2 in clauses 8.2.1.1, 8.2.1.2, and 8.2.1.3, respectively. When the current picture includes a memory_management_control_operation equal to 5, after the decoding of the current picture, tempPicOrderCnt is set equal to PicOrderCnt(CurrPic), TopFieldOrderCnt of the current picture (if any) is set equal to TopFieldOrderCnt − tempPicOrderCnt, and BottomFieldOrderCnt of the current picture (if any) is set equal to BottomFieldOrderCnt − tempPicOrderCnt.

The function PicOrderCnt(picX) is specified as follows:

if(picX is a frame or a complementary field pair)
  PicOrderCnt(picX) = Min(TopFieldOrderCnt, BottomFieldOrderCnt) of the frame or complementary field pair picX
else if(picX is a top field)
  PicOrderCnt(picX) = TopFieldOrderCnt of field picX (8-1)
else if(picX is a bottom field)
  PicOrderCnt(picX) = BottomFieldOrderCnt of field picX

Then DiffPicOrderCnt(picA, picB) is specified as follows:

$$\text{DiffPicOrderCnt(picA, picB)} = \text{PicOrderCnt(picA)} - \text{PicOrderCnt(picB)} \quad (8\text{-}2)$$

H.264, Section 8.2.

8.4.1.2.3 Derivation process for temporal direct luma motion vector and reference index prediction mode

This process is invoked when direct_spatial_mv_pred_flag is equal to 0 and any of the following conditions are true:

– mb_type is equal to B_Skip,

– mb_type is equal to B_Direct_16x16,

– sub_mb_type[mbPartIdx] is equal to B_Direct_8x8.

Inputs to this process are mbPartIdx and subMbPartIdx.

– Otherwise, the motion vectors mvL0, mvL1 are derived as scaled versions of the motion vector mvCol of the co-located sub-macroblock partition as specified below (see Figure 8-2).

$$tx = (16\,384 + \text{Abs}(td / 2)) / td \quad (8\text{-}197)$$

$$\text{DistScaleFactor} = \text{Clip3}(-1024, 1023, (tb * tx + 32) >> 6) \quad (8\text{-}198)$$

$$mvL0 = (\text{DistScaleFactor} * mvCol + 128) >> 8 \quad (8\text{-}199)$$

$$mvL1 = mvL0 - mvCol \quad (8\text{-}200)$$

where tb and td are derived as:

$$tb = \text{Clip3}(-128, 127, \text{DiffPicOrderCnt}(currPicOrField, pic0)) \quad (8\text{-}201)$$

$$td = \text{Clip3}(-128, 127, \text{DiffPicOrderCnt}(pic1, pic0)) \quad (8\text{-}202)$$

H.264, Section 8.4.1.2.3.

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Figure 8-2 illustrates the temporal direct-mode motion vector inference when the current picture is temporally between the reference picture from reference picture list 0 and the reference picture from reference picture list 1.

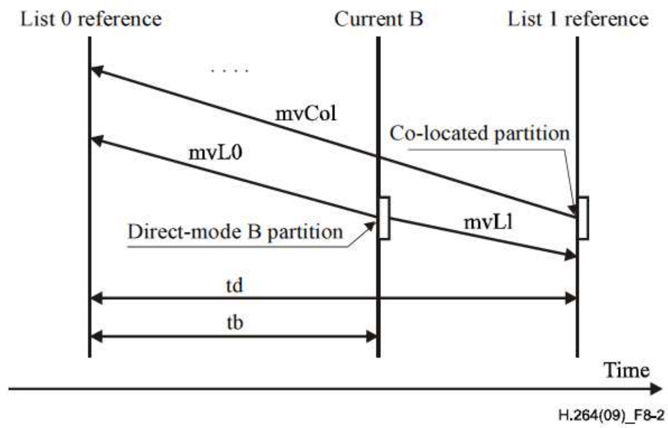

Figure 8-2 – Example for temporal direct-mode motion vector inference (informative)

H.264, Fig. 8-2.

110. The decoder of the Nokia H.264 Accused Products further executes a process comprising decoding the video picture by using said order value. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 3, 8.2.1, 8.4, and 8.4.1.2.3.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.65 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.66 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.75 **list 0 (list 1) motion vector**: A *motion vector* associated with a *reference index* pointing into *reference picture list 0* (*list 1*).

3.76 **list 0 (list 1) prediction**: *Inter prediction* of the content of a *slice* using a *reference index* pointing into *reference picture list 0* (*list 1*).

3.89 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.101 **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.109 **prediction**: An embodiment of the *prediction process*.

3.110 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

3.112 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.125 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.126 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P, B,* or *SP slice*. For the *decoding process* of a *P* or *SP slice,* there is one reference picture list. For the *decoding process* of a *B slice*, there are two reference picture lists.

3.127 **reference picture list 0**: A *reference picture list* used for *inter prediction* of a *P*, *B*, or *SP slice*. All *inter prediction* used for *P* and *SP slices* uses reference picture list 0. Reference picture list 0 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 1*.

3.128 **reference picture list 1**: A *reference picture list* used for *inter prediction* of a *B slice*. Reference picture list 1 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 0*.

3.129 **reference picture marking**: Specifies, in the bitstream, how the *decoded pictures* are marked for *inter prediction*.

H.264, Section 3.

8.2.1 Decoding process for picture order count

Outputs of this process are TopFieldOrderCnt (if applicable) and BottomFieldOrderCnt (if applicable).

Picture order counts are used to determine initial picture orderings for reference pictures in the decoding of B slices (see clauses 8.2.4.2.3 and 8.2.4.2.4), to determine co-located pictures (see clause 8.4.1.2.1) for deriving motion parameters in temporal or spatial direct mode, to represent picture order differences between frames or fields for motion vector derivation in temporal direct mode (see clause 8.4.1.2.3), for implicit mode weighted prediction in B slices (see clause 8.4.2.3.2), and for decoder conformance checking (see clause C.4).

H.264, Section 8.2.1.

8.4 Inter prediction process

This process is invoked when decoding P and B macroblock types.

Outputs of this process are Inter prediction samples for the current macroblock that are a 16x16 array $pred_L$ of luma samples and when ChromaArrayType is not equal to 0 two (MbWidthC)x(MbHeightC) arrays $pred_{Cb}$ and $pred_{Cr}$ of chroma samples, one for each of the chroma components Cb and Cr.

The Inter prediction process for a macroblock partition mbPartIdx and a sub-macroblock partition subMbPartIdx consists of the following ordered steps:

1. The derivation process for motion vector components and reference indices as specified in clause 8.4.1 is invoked.

   Inputs to this process are:

   – a macroblock partition mbPartIdx,

   – a sub-macroblock partition subMbPartIdx.

Outputs of this process are:

– luma motion vectors mvL0 and mvL1 and when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1

– reference indices refIdxL0 and refIdxL1

– prediction list utilization flags predFlagL0 and predFlagL1

– the sub-macroblock partition motion vector count subMvCnt.

H.264, Section 8.4.

8.4.1.2.3 Derivation process for temporal direct luma motion vector and reference index prediction mode

This process is invoked when direct_spatial_mv_pred_flag is equal to 0 and any of the following conditions are true:

– mb_type is equal to B_Skip,

– mb_type is equal to B_Direct_16x16,

– sub_mb_type[mbPartIdx] is equal to B_Direct_8x8.

Inputs to this process are mbPartIdx and subMbPartIdx.

– Otherwise, the motion vectors mvL0, mvL1 are derived as scaled versions of the motion vector mvCol of the co-located sub-macroblock partition as specified below (see Figure 8-2).

$$tx = (16\,384 + Abs(td / 2)) / td \qquad (8\text{-}197)$$

$$DistScaleFactor = Clip3(-1024, 1023, (tb * tx + 32) >> 6) \qquad (8\text{-}198)$$

$$mvL0 = (DistScaleFactor * mvCol + 128) >> 8 \qquad (8\text{-}199)$$

$$mvL1 = mvL0 - mvCol \qquad (8\text{-}200)$$

where tb and td are derived as:

$$tb = Clip3(-128, 127, DiffPicOrderCnt(currPicOrField, pic0)) \qquad (8\text{-}201)$$

$$td = Clip3(-128, 127, DiffPicOrderCnt(pic1, pic0)) \qquad (8\text{-}202)$$

H.264, Section 8.4.1.2.3.

111. Thus, as described above, the Nokia H.264 Accused Products infringe one or more claims of the ’339 Patent, including claim 10.

D. Nokia's Infringement of the '484 Apple H.264 Patent.

112. By way of example, and as shown below, the Nokia H.264 Accused Products infringe at least claim 9 of the '484 Patent because they are compliant with the relevant portions of the H.264 Standard. For example, the Nokia H.264 Accused Products comprise an encoder to execute a process comprising encoding a plurality of video pictures. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to Annex A.1, Annex C, Annex C.4, H.264 Summary, and § 0.2.

A.1 Requirements on video decoder capability

Capabilities of video decoders conforming to this Recommendation | International Standard are specified in terms of the ability to decode video streams conforming to the constraints of profiles and levels specified in this annex. For each such profile, the level supported for that profile shall also be expressed.

(Annex A.1).

Hypothetical reference decoder

(This annex forms an integral part of this Recommendation | International Standard.)

This annex specifies the hypothetical reference decoder (HRD) and its use to check bitstream and decoder conformance.

H.264, Annex C.

C.4 Decoder conformance

A decoder conforming to this Recommendation | International Standard fulfils the following requirements.

H.264, Annex C.4.

Summary

Recommendation ITU-T H.264 | International Standard ISO/IEC 14496-10 represents an evolution of the existing video coding standards (ITU-T H.261, ITU-T H.262, and ITU-T H.263) and it was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, Internet streaming, and communication. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

H.264, Summary.

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0.2 Purpose

This clause does not form an integral part of this Recommendation | International Standard.

This Recommendation | International Standard was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, internet streaming, and communication. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels.

H.264, Section 0.2.

113. The encoder of the Nokia H.264 Accused Products further encodes a plurality of video pictures, wherein a particular encoded video picture is associated with an order value that represents a position of the particular video picture with reference to a nearby video picture. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 3, 7.4.2.1.1, 8.2, 8.4.1.2.3, and Figure 8-2.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.65 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.66 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.75 **list 0 (list 1) motion vector**: A *motion vector* associated with a *reference index* pointing into *reference picture list 0* (*list 1*).

3.76 **list 0 (list 1) prediction**: *Inter prediction* of the content of a *slice* using a *reference index* pointing into *reference picture list 0* (*list 1*).

3.89 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.101 **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.109 **prediction**: An embodiment of the *prediction process*.

3.110 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

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3.112 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.125 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.126 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P*, *B*, or *SP slice*. For the *decoding process* of a *P* or *SP slice*, there is one reference picture list. For the *decoding process* of a *B slice*, there are two reference picture lists.

3.127 **reference picture list 0**: A *reference picture list* used for *inter prediction* of a *P*, *B*, or *SP slice*. All *inter prediction* used for *P* and *SP slices* uses reference picture list 0. Reference picture list 0 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 1*.

3.128 **reference picture list 1**: A *reference picture list* used for *inter prediction* of a *B slice*. Reference picture list 1 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 0*.

3.129 **reference picture marking**: Specifies, in the bitstream, how the *decoded pictures* are marked for *inter prediction*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.140 **slice**: An integer number of *macroblocks* or *macroblock pairs* ordered consecutively in the *raster scan* within a particular *slice group*. For the *primary coded picture*, the division of each *slice group* into slices is a *partitioning*. Although a slice contains *macroblocks* or *macroblock pairs* that are consecutive in the *raster scan* within a *slice group*, these *macroblocks* or *macroblock pairs* are not necessarily consecutive in the *raster scan* within the *picture*. The *macroblock addresses* are derived from the first *macroblock address* in a slice (as represented in the *slice header*) and the *macroblock to slice group map*, and, when a *picture* is coded using three separate colour planes, a colour plane identifier.

3.145 **slice header**: A part of a coded *slice* containing the data elements pertaining to the first or all *macroblocks* represented in the *slice*.

H.264, Section 3.

log2_max_pic_order_cnt_lsb_minus4 specifies the value of the variable MaxPicOrderCntLsb that is used in the decoding process for picture order count as specified in clause 8.2.1 as follows:

$$\text{MaxPicOrderCntLsb} = 2^{(\text{log2\_max\_pic\_order\_cnt\_lsb\_minus4} + 4)} \qquad (7\text{-}11)$$

The value of log2_max_pic_order_cnt_lsb_minus4 shall be in the range of 0 to 12, inclusive.

H.264, Section 7.4.2.1.1.

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8.2 Slice decoding process

8.2.1 Decoding process for picture order count

Outputs of this process are TopFieldOrderCnt (if applicable) and BottomFieldOrderCnt (if applicable).

Picture order counts are used to determine initial picture orderings for reference pictures in the decoding of B slices (see clauses 8.2.4.2.3 and 8.2.4.2.4), to determine co-located pictures (see clause 8.4.1.2.1) for deriving motion parameters in temporal or spatial direct mode, to represent picture order differences between frames or fields for motion vector derivation in temporal direct mode (see clause 8.4.1.2.3), for implicit mode weighted prediction in B slices (see clause 8.4.2.3.2), and for decoder conformance checking (see clause C.4).

TopFieldOrderCnt and BottomFieldOrderCnt are derived by invoking one of the decoding processes for picture order count type 0, 1, and 2 in clauses 8.2.1.1, 8.2.1.2, and 8.2.1.3, respectively. When the current picture includes a memory_management_control_operation equal to 5, after the decoding of the current picture, tempPicOrderCnt is set equal to PicOrderCnt(CurrPic), TopFieldOrderCnt of the current picture (if any) is set equal to TopFieldOrderCnt − tempPicOrderCnt, and BottomFieldOrderCnt of the current picture (if any) is set equal to BottomFieldOrderCnt − tempPicOrderCnt.

The function PicOrderCnt(picX) is specified as follows:

```
if( picX is a frame or a complementary field pair )
   PicOrderCnt( picX ) = Min( TopFieldOrderCnt, BottomFieldOrderCnt ) of the frame or complementary field
pair picX
else if( picX is a top field )
   PicOrderCnt( picX ) = TopFieldOrderCnt of field picX                                  (8-1)
else if( picX is a bottom field )
   PicOrderCnt( picX ) = BottomFieldOrderCnt of field picX
```

Then DiffPicOrderCnt(picA, picB) is specified as follows:

DiffPicOrderCnt(picA, picB) = PicOrderCnt(picA) − PicOrderCnt(picB) (8-2)

H.264, Section 8.2.

8.4.1.2.3 Derivation process for temporal direct luma motion vector and reference index prediction mode

This process is invoked when direct_spatial_mv_pred_flag is equal to 0 and any of the following conditions are true:

– mb_type is equal to B_Skip,

– mb_type is equal to B_Direct_16x16,

– sub_mb_type[mbPartIdx] is equal to B_Direct_8x8.

Inputs to this process are mbPartIdx and subMbPartIdx.

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– Otherwise, the motion vectors mvL0, mvL1 are derived as scaled versions of the motion vector mvCol of the co-located sub-macroblock partition as specified below (see Figure 8-2).

$$tx = (16\,384 + Abs(td / 2)) / td \quad (8\text{-}197)$$

$$DistScaleFactor = Clip3(-1024, 1023, (tb * tx + 32) >> 6) \quad (8\text{-}198)$$

$$mvL0 = (DistScaleFactor * mvCol + 128) >> 8 \quad (8\text{-}199)$$

$$mvL1 = mvL0 - mvCol \quad (8\text{-}200)$$

where tb and td are derived as:

$$tb = Clip3(-128, 127, DiffPicOrderCnt(currPicOrField, pic0)) \quad (8\text{-}201)$$

$$td = Clip3(-128, 127, DiffPicOrderCnt(pic1, pic0)) \quad (8\text{-}202)$$

H.264, Section 8.4.1.2.3.

114. The encoder of the Nokia H.264 Accused Products further performs the step of encoding a plurality of slice headers associated with the particular video picture, each slice header in the plurality of slice headers comprising an encoded instance of the same order value. As shown below, the corresponding functionality is described in the H.264 Standard, including but not limited to §§ 3, 7.4.2.1.1, 8.2, 8.4, and 8.4.1.2.3.

3.8 **B slice**: A *slice* that may be decoded using *intra prediction* or *inter prediction* using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.65 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.66 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.75 **list 0 (list 1) motion vector**: A *motion vector* associated with a *reference index* pointing into *reference picture list 0* (*list 1*).

3.76 **list 0 (list 1) prediction**: *Inter prediction* of the content of a *slice* using a *reference index* pointing into *reference picture list 0* (*list 1*).

3.89 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.101 **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.108 **picture order count**: A variable that is associated with each *coded field* and each *field* of a *coded frame* and has a value that is non-decreasing with increasing *field* position in *output order* relative to the first output *field* of the previous *IDR picture* in *decoding order* or relative to the first output *field* of the previous *picture*, in *decoding order*, that contains a *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.109 **prediction**: An embodiment of the *prediction process*.

3.110 **prediction process**: The use of a *predictor* to provide an estimate of the sample value or data element currently being decoded.

3.112 **predictor**: A combination of specified values or previously decoded sample values or data elements used in the *decoding process* of subsequent sample values or data elements.

3.125 **reference picture**: A *picture* with nal_ref_idc not equal to 0. A *reference picture* contains samples that may be used for *inter prediction* in the *decoding process* of subsequent *pictures* in *decoding order*.

3.126 **reference picture list**: A list of *reference pictures* that is used for *inter prediction* of a *P*, *B*, or *SP slice*. For the *decoding process* of a *P* or *SP slice*, there is one reference picture list. For the *decoding process* of a *B slice*, there are two reference picture lists.

3.127 **reference picture list 0**: A *reference picture list* used for *inter prediction* of a *P*, *B*, or *SP slice*. All *inter prediction* used for *P* and *SP slices* uses reference picture list 0. Reference picture list 0 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 1*.

3.128 **reference picture list 1**: A *reference picture list* used for *inter prediction* of a *B slice*. Reference picture list 1 is one of two *reference picture lists* used for *inter prediction* for a *B slice*, with the other being *reference picture list 0*.

3.129 **reference picture marking**: Specifies, in the bitstream, how the *decoded pictures* are marked for *inter prediction*.

H.264, Section 3.

log2_max_pic_order_cnt_lsb_minus4 specifies the value of the variable MaxPicOrderCntLsb that is used in the decoding process for picture order count as specified in clause 8.2.1 as follows:

$$\text{MaxPicOrderCntLsb} = 2^{(\text{log2\_max\_pic\_order\_cnt\_lsb\_minus4} + 4)} \quad (7\text{-}11)$$

The value of log2_max_pic_order_cnt_lsb_minus4 shall be in the range of 0 to 12, inclusive.

H.264, Section 7.4.2.1.1.

8.2.1 Decoding process for picture order count

Outputs of this process are TopFieldOrderCnt (if applicable) and BottomFieldOrderCnt (if applicable).

Picture order counts are used to determine initial picture orderings for reference pictures in the decoding of B slices (see clauses 8.2.4.2.3 and 8.2.4.2.4), to determine co-located pictures (see clause 8.4.1.2.1) for deriving motion parameters in temporal or spatial direct mode, to represent picture order differences between frames or fields for motion vector derivation in temporal direct mode (see clause 8.4.1.2.3), for implicit mode weighted prediction in B slices (see clause 8.4.2.3.2), and for decoder conformance checking (see clause C.4).

TopFieldOrderCnt and BottomFieldOrderCnt are derived by invoking one of the decoding processes for picture order count type 0, 1, and 2 in clauses 8.2.1.1, 8.2.1.2, and 8.2.1.3, respectively. When the current picture includes a memory_management_control_operation equal to 5, after the decoding of the current picture, tempPicOrderCnt is set equal to PicOrderCnt(CurrPic), TopFieldOrderCnt of the current picture (if any) is set equal to TopFieldOrderCnt − tempPicOrderCnt, and BottomFieldOrderCnt of the current picture (if any) is set equal to BottomFieldOrderCnt − tempPicOrderCnt.

H.264, Section 8.2.

8.4 Inter prediction process

This process is invoked when decoding P and B macroblock types.

Outputs of this process are Inter prediction samples for the current macroblock that are a 16x16 array $pred_L$ of luma samples and when ChromaArrayType is not equal to 0 two (MbWidthC)x(MbHeightC) arrays $pred_{Cb}$ and $pred_{Cr}$ of chroma samples, one for each of the chroma components Cb and Cr.

The Inter prediction process for a macroblock partition mbPartIdx and a sub-macroblock partition subMbPartIdx consists of the following ordered steps:

1. The derivation process for motion vector components and reference indices as specified in clause 8.4.1 is invoked.

   Inputs to this process are:

   – a macroblock partition mbPartIdx,

   – a sub-macroblock partition subMbPartIdx.

Outputs of this process are:

– luma motion vectors mvL0 and mvL1 and when ChromaArrayType is not equal to 0, the chroma motion vectors mvCL0 and mvCL1

– reference indices refIdxL0 and refIdxL1

– prediction list utilization flags predFlagL0 and predFlagL1

– the sub-macroblock partition motion vector count subMvCnt.

H.264, Section 8.4.

8.4.1.2.3 Derivation process for temporal direct luma motion vector and reference index prediction mode

This process is invoked when direct_spatial_mv_pred_flag is equal to 0 and any of the following conditions are true:

– mb_type is equal to B_Skip,

– mb_type is equal to B_Direct_16x16,

– sub_mb_type[mbPartIdx] is equal to B_Direct_8x8.

Inputs to this process are mbPartIdx and subMbPartIdx.

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– Otherwise, the motion vectors mvL0, mvL1 are derived as scaled versions of the motion vector mvCol of the co-located sub-macroblock partition as specified below (see Figure 8-2).

$$tx = (16\,384 + \mathrm{Abs}(td / 2)) / td \quad (8\text{-}197)$$

$$\mathrm{DistScaleFactor} = \mathrm{Clip3}(-1024, 1023, (tb * tx + 32) >> 6) \quad (8\text{-}198)$$

$$mvL0 = (\mathrm{DistScaleFactor} * mvCol + 128) >> 8 \quad (8\text{-}199)$$

$$mvL1 = mvL0 - mvCol \quad (8\text{-}200)$$

where tb and td are derived as:

$$tb = \mathrm{Clip3}(-128, 127, \mathrm{DiffPicOrderCnt}(currPicOrField, pic0)) \quad (8\text{-}201)$$

$$td = \mathrm{Clip3}(-128, 127, \mathrm{DiffPicOrderCnt}(pic1, pic0)) \quad (8\text{-}202)$$

H.264, Section 8.4.1.2.3.

115. Thus, as described above, the Nokia H.264 Accused Products infringe one or more claims of the ’484 Patent, including claim 9.

APPLE’S LTE PATENTS

116. For many years, the European Telecommunications Standards Institute (“ETSI”) has been involved in facilitating the development of global standards for mobile telecommunication technologies. ETSI was one of the founding members of the 3rd Generation Partnership Project (“3GPP”) which focuses on cellular telecommunication network technologies, e.g., communications between cellular telephones and network infrastructure equipment. 3GPP has particular responsibility for coordinating the development of the Long Term Evolution (“LTE”) standard as well as the development of the higher capacity LTE-Advanced standard.

117. On June 23, 2009, the USPTO duly and legally issued U.S. Patent No. 7,551,546 (“the ’546 Patent”), entitled “Dual-mode shared OFDM methods/transmitters, receivers and systems,” to inventors Jianglei Ma, Wen Tong, Ming Jia, Peiying Zhu, and Dong-Sheng Yu. A true and correct copy of the ’546 Patent is attached hereto as Exhibit 5.

118. On December 27, 2011, the USPTO duly and legally issued U.S. Patent No. 8,085,814 (“the ’814 Patent”), entitled “Frame structure, system and method for OFDM communications,” to inventors Jianglei Ma, Ming Jia, Peiying Zhu, and Wen Tong. A true and correct copy of the ’814 Patent is attached hereto as Exhibit 6.

119. On March 10, 2015, the USPTO duly and legally issued U.S. Patent No. 8,976,734 (“the ’734 Patent”), entitled “Hybrid ARQ schemes with soft combining in variable rate packet data applications,” to inventors Wen Tong, Leo L. Strawczynski, Shalini S. Periyalwar, and Claude Royer. A true and correct copy of the ’734 Patent is attached hereto as Exhibit 7.

120. On August 11, 2015, the USPTO duly and legally issued U.S. Patent No. 9,106,288 (“the ’288 Patent”), entitled “Pilot scheme for a MIMO communication system,” to inventors Jianglei Ma, Ming Jia, Hua Xu, Wen Tong, Peiying Zhu, and Abdi Moussa. A true and correct copy of the ’288 Patent is attached hereto as Exhibit 8.

121. The ’288, ’546, ’814, and ’734 Patents are collectively referred to herein as the “Apple LTE Patents.”

122. The inventions claimed in each of the Apple LTE Patents were declared essential to the LTE standard in declarations submitted to ETSI by reference to each of those patent’s families on June 11, 2008.

123. Apple exclusively owns all rights, title, and interest in the Apple LTE Patents, including the right to recover past and future damages.

124. 122. Nokia is not licensed to practice the Apple LTE Patents, but Apple has been willing to license its asserted LTE patents on FRAND terms. [redacted]

[redacted].

GENERAL ALLEGATIONS REGARDING NOKIA'S INFRINGEMENT OF THE APPLE LTE PATENTS

125. On information and belief, Nokia manufactures, uses, markets, offers for sale, sells, and/or imports in the United States, or has manufactured, used, marketed, offered for sale, sold, and/or imported in the United States cellular base stations with LTE and LTE-Advanced cellular communication capabilities (such as LTE and LTE-Advanced eNodeBs) that comply with the LTE and/or LTE-Advanced cellular networking standard ("the Nokia LTE Accused Products").

126. One example of the Nokia LTE Accused Products is Nokia's Flexi Multiradio 10 Base Station products and any other base stations sold by Nokia.

127. On information and belief, the Flexi Multiradio 10 Base Station products comply with the LTE (3GPP Releases 8 and 9) and LTE-Advanced (3GPP Release 10) standards. For example, Nokia has stated:

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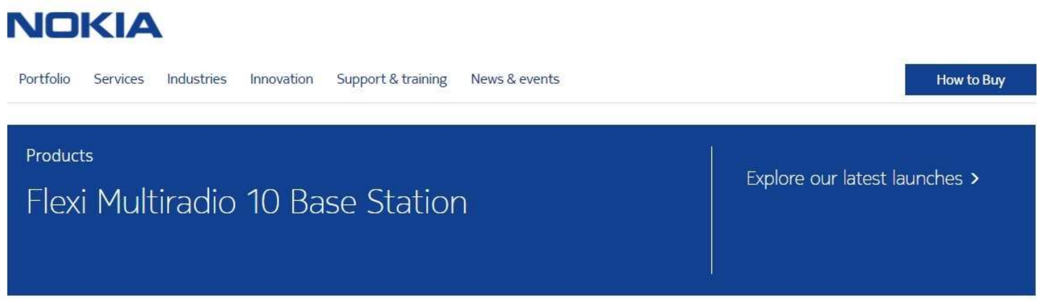
NOKIA

Portfolio Services Industries Innovation Support & training News & events How to Buy

Products

Flexi Multiradio 10 Base Station

Explore our latest launches >

* * *


Benefits

Highlights

- IP65 rated - no cooling, cabinet or shelter needed
- Software enables capacity sharing across GSM, HSPA and LTE
- World record LTE-A speed - 4 Gbps
- Flexible radio options for the lowest cost per megabyte
- Zero CO_2 emission site solution – up to 70 percent lower energy consumption
- Common base station OAM for multiradio sites
- Single transport function with common IP host

* * *


We supply networks to operators who serve more than four billion people around the world. SingleRAN can help you support increased traffic over your multiradio network while cutting costs.

Radio Access
Smart networks help your customers fully enjoy their smart devices

LTE/LTE-Advanced
The highest data rates and shortest latency times

WCDMA/HSPA
The best smartphone experience

GSM Radio Access Networks
The broadest global coverage, serving 80 percent of all mobile subscribers

Source: http://networks.nokia.com/products/flexi-multiradio-10-base-station.

128. On information and belief, Alcatel-Lucent USA Inc. manufactures, uses, markets, offers for sale, sells, and/or imports in the United States, or has manufactured, used, marketed, offered for sale, sold, and/or imported in the United States cellular base stations with LTE and LTE-Advanced cellular communication capabilities, similar in functionality to the Nokia Flexi Multiradio 10 Base Station described above. These products include, for example, the 9100 Multistandard Base Station (MBS), the 9412 eNodeB Compact, the 9442 Remote Radio Head, the 9760 Small Cells, and the 9926 Distributed Base Station (DBS), and are included within the definition of the Nokia LTE Accused Products for the purposes of these counterclaims.

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129. These and other Nokia products that comply with the LTE standard infringe at least one claim in each of Apple's LTE Patents, as shown below. The claims presented below are illustrative and exemplary and by no means constitute the total set of claims Apple intends to assert, nor show every explanation of how the Nokia LTE Accused Products infringe the claims of the Apple LTE Patents.

A. Nokia's Infringement of the '546 Apple LTE Patent.

130. By way of example, and as shown below, the Nokia LTE Accused Products infringe claim 1 of the '546 Patent because they comply with the relevant portions of the LTE-Advanced standard. For example, the Nokia LTE Accused Products comprise a wireless terminal for communicating over a shared OFDM band. As shown below, the corresponding functionality is described in the LTE-Advanced standard, including but not limited to 3GPP TS 36.211 (v 10.7.0) § 6.4 and 3GPP TS 36.300 (v 10.12.0) §§ 5, 5.1 & 11.1.

> ### 11.1 Basic Scheduler Operation
>
> MAC in eNB includes dynamic resource schedulers that allocate physical layer resources for the DL-SCH and UL-SCH transport channels. Different schedulers operate for the DL-SCH and UL-SCH.
>
> The scheduler should take account of the traffic volume and the QoS requirements of each UE and associated radio bearers, when sharing resources between UEs. Only "per UE" grants are used to grant the right to transmit on the UL-SCH (i.e. there are no "per UE per RB" grants).
>
> Schedulers may assign resources taking account the radio conditions at the UE identified through measurements made at the eNB and/or reported by the UE.
>
> Radio resource allocations can be valid for one or multiple TTIs.
>
> Resource assignment consists of physical resource blocks (PRB) and MCS. Allocations for time periods longer than one TTI might also require additional information (allocation time, allocation repetition factor…).
>
> When CA is configured, a UE may be scheduled over multiple serving cells simultaneously but at most one random access procedure shall be ongoing at any time. Cross-carrier scheduling with the Carrier Indicator Field (CIF) allows the PDCCH of a serving cell to schedule resources on another serving cell but with the following restrictions:
>
> - Cross-carrier scheduling does not apply to PCell i.e. PCell is always scheduled via its PDCCH;
> - When the PDCCH of an SCell is configured, cross-carrier scheduling does not apply to this SCell i.e. it is always scheduled via its PDCCH;
> - When the PDCCH of an SCell is not configured, cross-carrier scheduling applies and this SCell is always scheduled via the PDCCH of one other serving cell.

3GPP TS 36.300 (v 10.12.0) § 11.1.

> **Physical downlink shared channel (PDSCH)**
>
> - Carries the DL-SCH and PCH.

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3GPP TS 36.300 (v 10.12.0) § 5.

6.4 Physical downlink shared channel

The physical downlink shared channel shall be processed and mapped to resource elements as described in Section 6.3 with the following exceptions:

- In resource blocks in which UE-specific reference signals are not transmitted, the PDSCH shall be transmitted on the same set of antenna ports as the PBCH, which is one of $\{0\}$, $\{0,1\}$, or $\{0,1,2,3\}$
- In resource blocks in which UE-specific reference signals are transmitted, the PDSCH shall be transmitted on antenna port(s) $\{5\}$, $\{7\}$, $\{8\}$, or $p \in \{7,8,...,\upsilon+6\}$, where υ is the number of layers used for transmission of the PDSCH.
- If PDSCH is transmitted in MBSFN subframes as defined in [4], the PDSCH shall be transmitted on one or several of antenna port(s) $p \in \{7,8,...,\upsilon+6\}$, where υ is the number of layers used for transmission of the PDSCH.

3GPP TS 36.211 (v 10.7.0) § 6.4.

5.1 Downlink Transmission Scheme

5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110 per carrier or per Cell in case of CA.

In addition there is also a reduced sub-carrier spacingΔf_{low} = 7.5 kHz, only for MBMS-dedicated cell.

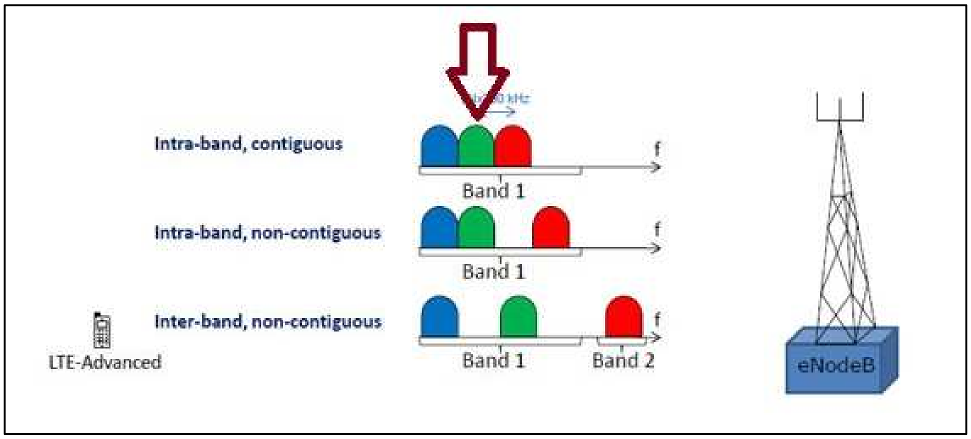
In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively.

- Normal cyclic prefix: T_{CP} = 160×Ts (OFDM symbol #0) , T_{CP} = 144×Ts (OFDM symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (OFDM symbol #0 to OFDM symbol #5)

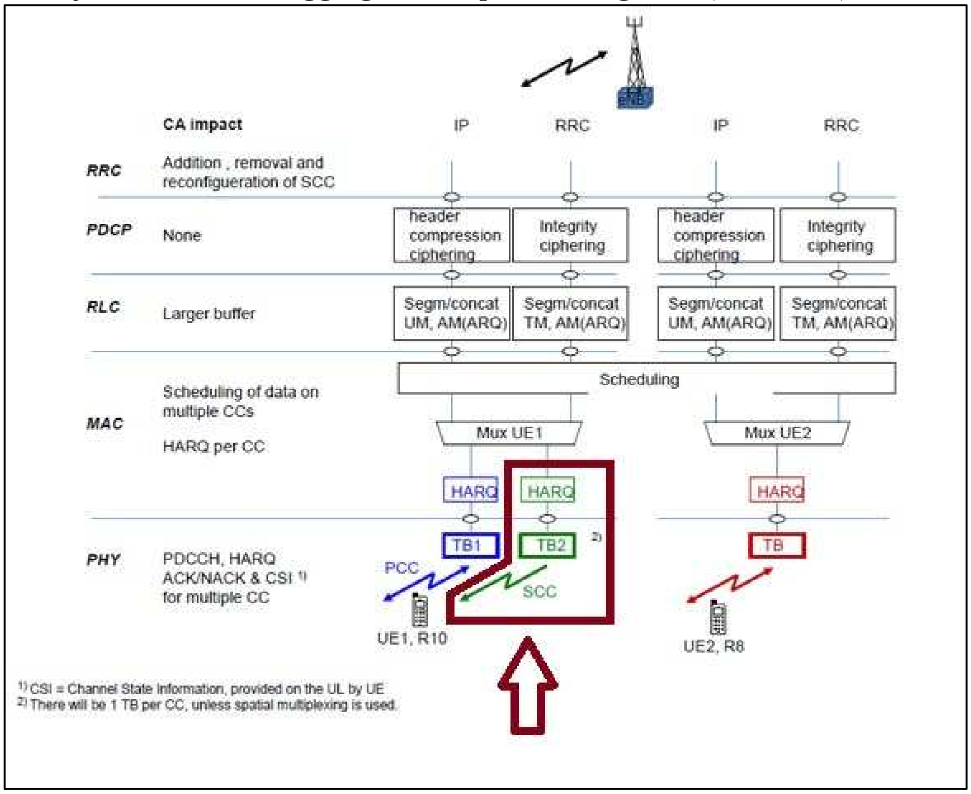
  where T_s = 1/ (2048 × Δf)

3GPP TS 36.300 (v 10.12.0) § 5.1.

131. The Nokia LTE Accused Products further comprise a first transmit chain configured to generate and transmit a low rate mode OFDM transmission in a first frequency band of the shared OFDM band in a first subset of a plurality of OFDM transmission intervals. As shown below, the corresponding functionality is described in the LTE-Advanced standard, including but not limited to 3GPP TS 36.101 (v 10.3.0) §§ 5.6 & 5.6A.1, 3GPP TS 36.211 (v 10.7.0) §§ 6.2.2, 6.2.3, 6.3 & 6.4, 3GPP TS 36.213 (v 10.13.0) §§ 7.1.6., 7.1.6.2 & 7.1.6.3, 3GPP TS 36.300 (v 10.12.0) §§ 5.5, 6.4, 7.5 & 11.1, as well as secondary materials on 3GPP's website.



3GPP: Carrier Aggregation Explained, http://www.3gpp.org/technologies/keywords-acronyms/101-carrier-aggregation-explained, Figure 2 (annotated).



3GPP: Carrier Aggregation Explained, http://www.3gpp.org/technologies/keywords-acronyms/101-carrier-aggregation-explained, Figure 4 (annotated).

> When carrier aggregation is used there are a number of serving cells, one for each component carrier. The coverage of the serving cells may differ, for example due to that CCs on different frequency bands will experience different pathloss, see figure 3. The RRC connection is only handled by one cell, the Primary serving cell, served by the Primary component carrier (DL and UL PCC). It is also on the DL PCC that the UE receives NAS information, such as security parameters. In idle mode the UE listens to system information on the DL PCC. On the UL PCC PUCCH is sent. The other component carriers are all referred to as Secondary component carriers (DL and UL SCC), serving the Secondary serving cells, see

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> figure 3. The SCCs are added and removed as required, while the PCC is only changed at handover.

3GPP: Carrier Aggregation Explained, http://www.3gpp.org/technologies/keywords-acronyms/101-carrier-aggregation-explained.

6.3 General structure for downlink physical channels

This section describes a general structure, applicable to more than one physical channel.

The baseband signal representing a downlink physical channel is defined in terms of the following steps:

- scrambling of coded bits in each of the codewords to be transmitted on a physical channel
- modulation of scrambled bits to generate complex-valued modulation symbols
- mapping of the complex-valued modulation symbols onto one or several transmission layers
- precoding of the complex-valued modulation symbols on each layer for transmission on the antenna ports
- mapping of complex-valued modulation symbols for each antenna port to resource elements
- generation of complex-valued time-domain OFDM signal for each antenna port

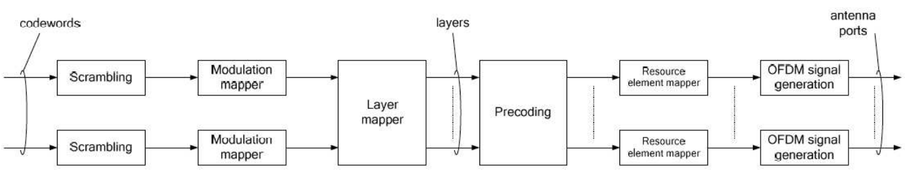

Figure 6.3-1: Overview of physical channel processing.

3GPP TS 36.211 (v 10.7.0) § 6.3.

6.4 Physical downlink shared channel

The physical downlink shared channel shall be processed and mapped to resource elements as described in Section 6.3 with the following exceptions:

- In resource blocks in which UE-specific reference signals are not transmitted, the PDSCH shall be transmitted on the same set of antenna ports as the PBCH, which is one of $\{0\}$, $\{0,1\}$, or $\{0,1,2,3\}$
- In resource blocks in which UE-specific reference signals are transmitted, the PDSCH shall be transmitted on antenna port(s) $\{5\}, \{7\}, \{8\}$, or $p \in \{7,8,...,\upsilon+6\}$, where υ is the number of layers used for transmission of the PDSCH.
- If PDSCH is transmitted in MBSFN subframes as defined in [4], the PDSCH shall be transmitted on one or several of antenna port(s) $p \in \{7,8,...,\upsilon+6\}$, where υ is the number of layers used for transmission of the PDSCH.

3GPP TS 36.211 (v 10.7.0) § 6.4.

6.4 Carrier Aggregation

In case of CA, the multi-carrier nature of the physical layer is only exposed to the MAC layer for which one HARQ entity is required per serving cell;

- In both uplink and downlink, there is one independent hybrid-ARQ entity per serving cell and one transport block is generated per TTI per serving cell in the absence of spatial multiplexing. Each transport block and its potential HARQ retransmissions are mapped to a single serving cell.

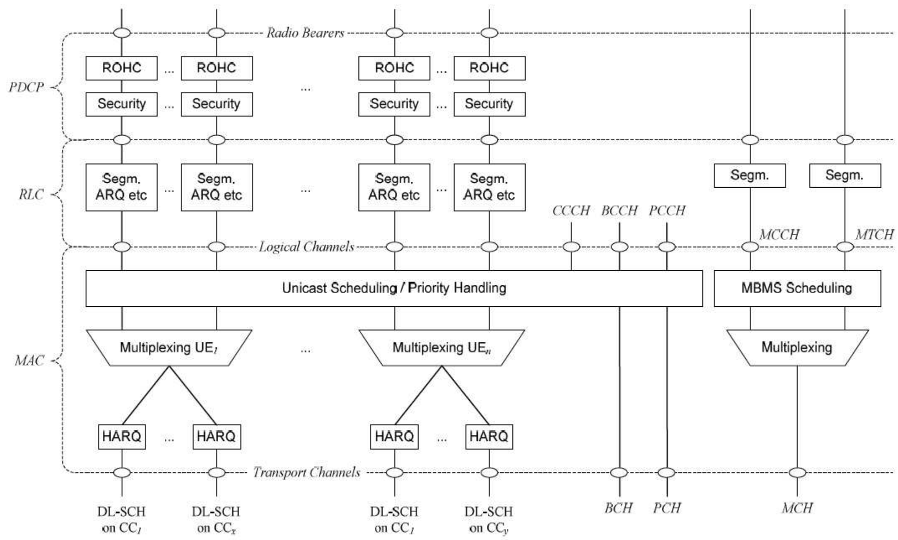

Figure 6.4-1: Layer 2 Structure for DL with CA configured

3GPP TS 36.300 (v 10.12.0) § 6.4.

5.5 Carrier Aggregation

In Carrier Aggregation (CA), two or more Component Carriers (CCs) are aggregated in order to support wider transmission bandwidths up to 100MHz. A UE may simultaneously receive or transmit on one or multiple CCs depending on its capabilities:

- A Rel-10 UE with reception and/or transmission capabilities for CA can simultaneously receive and/or transmit on multiple CCs corresponding to multiple serving cells;
- A Rel-8/9 UE can receive on a single CC and transmit on a single CC corresponding to one serving cell only.

CA is supported for both contiguous and non-contiguous CCs with each CC limited to a maximum of 110 Resource Blocks in the frequency domain using the Rel-8/9 numerology.

It is possible to configure a UE to aggregate a different number of CCs originating from the same eNB and of possibly different bandwidths in the UL and the DL.

3GPP TS 36.300 (v 10.12.0) § 5.5.

7.5 Carrier Aggregation

When CA is configured, the UE only has one RRC connection with the network. At RRC connection establishment/re-establishment/handover, one serving cell provides the NAS mobility information (e.g. TAI), and at RRC connection re-establishment/handover, one serving cell provides the security input. This cell is referred to as the Primary Cell (PCell). In the downlink, the carrier corresponding to the PCell is the Downlink Primary Component Carrier (DL PCC) while in the uplink it is the Uplink Primary Component Carrier (UL PCC).

Depending on UE capabilities, Secondary Cells (SCells) can be configured to form together with the PCell a set of serving cells. In the downlink, the carrier corresponding to an SCell is a Downlink Secondary Component Carrier (DL SCC) while in the uplink it is an Uplink Secondary Component Carrier (UL SCC).

The configured set of serving cells for a UE therefore always consists of one PCell and one or more SCells:

3GPP TS 36.300 (v 10.12.0) § 7.5.

Radio resource allocations can be valid for one or multiple TTIs.

Resource assignment consists of physical resource blocks (PRB) and MCS. Allocations for time periods longer than one TTI might also require additional information (allocation time, allocation repetition factor…).

When CA is configured, a UE may be scheduled over multiple serving cells simultaneously but at most one random access procedure shall be ongoing at any time. Cross-carrier scheduling with the Carrier Indicator Field (CIF) allows the PDCCH of a serving cell to schedule resources on another serving cell but with the following restrictions:

- Cross-carrier scheduling does not apply to PCell i.e. PCell is always scheduled via its PDCCH;
- When the PDCCH of an SCell is configured, cross-carrier scheduling does not apply to this SCell i.e. it is always scheduled via its PDCCH;
- When the PDCCH of an SCell is not configured, cross-carrier scheduling applies and this SCell is always scheduled via the PDCCH of one other serving cell.

3GPP TS 36.300 (v 10.12.0) § 11.1.

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1: Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

3GPP TS 36.101 (v 10.3.0) § 5.6.

5.6A.1 Channel bandwidths per operating band for CA

The requirements in this specification apply to the combination of CA bandwidth class and CA operating bands shown in Table 5.6A.1-1.

Indexing letter in CA configuration acronym refers to supported CA bandwidth class. In case no CA bandwidth class is labelled acronym refers to all specified combinations of CA bandwidth class and CA operating band. CA configuration refers to a combination of CA operating band and CA bandwidth class supported by a UE.

DL component carrier combinations for a given CA operating band shall be symmetrical in relation to channel centre unless stated otherwise in table 5.6A.1-1 or 5.6A.1-2.

Table 5.6A.1-1: Supported E-UTRA bandwidths per CA configuration for intra-band contiguous CA

CA operating band / channel bandwidth							
E-UTRA CA Configuration	**E-UTRA Bands**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
CA_1C	1					Yes	Yes
CA_40C[1]	40				Yes	Yes	Yes
Note 1: Combinations of component carriers with unequal channel bandwidth should be considered. The maximum number of CCs for combination is two.							

Table 5.6A.1-2: Supported E-UTRA bandwidths per CA configuration for inter-band CA

CA operating / channel bandwidth							
E-UTRA CA Configuration	**E-UTRA Bands**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
CA_1A-5A	1				Yes		
	5				Yes		

3GPP TS 36.101 (v 10.3.0) § 5.6A.1.

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7.1.6 Resource allocation

The UE shall interpret the resource allocation field depending on the PDCCH DCI format detected. A resource allocation field in each PDCCH includes two parts, a resource allocation header field and information consisting of the actual resource block assignment. PDCCH DCI formats 1, 2, 2A, 2B and 2C with type 0 and PDCCH DCI formats 1, 2, 2A,2B and 2C with type 1 resource allocation have the same format and are distinguished from each other via the single bit resource allocation header field which exists depending on the downlink system bandwidth (subclause 5.3.3.1 of

[4]), where type 0 is indicated by 0 value and type 1 is indicated otherwise. PDCCH with DCI format 1A, 1B, 1C and 1D have a type 2 resource allocation while PDCCH with DCI format 1, 2, 2A, 2B and 2C have type 0 or type 1 resource allocation. PDCCH DCI formats with a type 2 resource allocation do not have a resource allocation header field.

3GPP TS 36.213 (v 10.13.0) § 7.1.6.

7.1.6.2 Resource allocation type 1

In resource allocations of type 1, a resource block assignment information of size N_{RBG} indicates to a scheduled UE the VRBs from the set of VRBs from one of *P* RBG subsets. The virtual resource blocks used are of localized type as defined in subclause 6.2.3.1 of [3]. Also *P* is the RBG size associated with the system bandwidth as shown in Table 7.1.6.1-1. A RBG subset p, where $0 \le p < P$, consists of every P th RBG starting from RBG p. The resource block assignment information consists of three fields [4].

The first field with $\lceil \log_2(P) \rceil$ bits is used to indicate the selected RBG subset among P RBG subsets.

The second field with one bit is used to indicate a shift of the resource allocation span within a subset. A bit value of 1 indicates shift is triggered. Shift is not triggered otherwise.

The third field includes a bitmap, where each bit of the bitmap addresses a single VRB in the selected RBG subset in such a way that MSB to LSB of the bitmap are mapped to the VRBs in the increasing frequency order. The VRB is allocated to the UE if the corresponding bit value in the bit field is 1, the VRB is not allocated to the UE otherwise. The portion of the bitmap used to address VRBs in a selected RBG subset has size $N_{\mathrm{RB}}^{\mathrm{TYPE1}}$ and is defined as

$$N_{\mathrm{RB}}^{\mathrm{TYPE1}} = \left\lceil N_{\mathrm{RB}}^{\mathrm{DL}} / P \right\rceil - \lceil \log_2(P) \rceil - 1$$

The addressable VRB numbers of a selected RBG subset start from an offset, $\Delta_{\mathrm{shift}}(p)$ to the smallest VRB number within the selected RBG subset, which is mapped to the MSB of the bitmap. The offset is in terms of the number of VRBs and is done within the selected RBG subset. If the value of the bit in the second field for shift of the resource allocation span is set to 0, the offset for RBG subset p is given by $\Delta_{\mathrm{shift}}(p) = 0$. Otherwise, the offset for RBG subset p is given by $\Delta_{\mathrm{shift}}(p) = N_{\mathrm{RB}}^{\mathrm{RBG\ subset}}(p) - N_{\mathrm{RB}}^{\mathrm{TYPE1}}$, where the LSB of the bitmap is justified with the

highest VRB number within the selected RBG subset. $N_{\mathrm{RB}}^{\mathrm{RBG\ subset}}(p)$ is the number of VRBs in RBG subset p and can be calculated by the following equation,

$$N_{\mathrm{RB}}^{\mathrm{RBG\ subset}}(p) = \begin{cases} \left\lfloor \dfrac{N_{\mathrm{RB}}^{\mathrm{DL}} - 1}{P^2} \right\rfloor \cdot P + P & , p < \left\lfloor \dfrac{N_{\mathrm{RB}}^{\mathrm{DL}} - 1}{P} \right\rfloor \bmod P \\ \left\lfloor \dfrac{N_{\mathrm{RB}}^{\mathrm{DL}} - 1}{P^2} \right\rfloor \cdot P + (N_{\mathrm{RB}}^{\mathrm{DL}} - 1) \bmod P + 1 & , p = \left\lfloor \dfrac{N_{\mathrm{RB}}^{\mathrm{DL}} - 1}{P} \right\rfloor \bmod P \\ \left\lfloor \dfrac{N_{\mathrm{RB}}^{\mathrm{DL}} - 1}{P^2} \right\rfloor \cdot P & , p > \left\lfloor \dfrac{N_{\mathrm{RB}}^{\mathrm{DL}} - 1}{P} \right\rfloor \bmod P \end{cases}$$

Consequently, when RBG subset p is indicated, bit i for $i = 0,1,\cdots,N_{\mathrm{RB}}^{\mathrm{TYPE1}} - 1$ in the bitmap field indicates VRB number,

$$n_{\mathrm{VRB}}^{\mathrm{RBG\ subset}}(p) = \left\lfloor \frac{i + \Delta_{\mathrm{shift}}(p)}{P} \right\rfloor P^2 + p \cdot P + \left(i + \Delta_{\mathrm{shift}}(p)\right) \bmod P\,.$$

3GPP TS 36.213 (v 10.13.0) § 7.1.6.2.

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7.1.6.3 Resource allocation type 2

In resource allocations of type 2, the resource block assignment information indicates to a scheduled UE a set of contiguously allocated localized virtual resource blocks or distributed virtual resource blocks. In case of resource allocation signalled with PDCCH DCI format 1A, 1B or 1D, one bit flag indicates whether localized virtual resource blocks or distributed virtual resource blocks are assigned (value 0 indicates Localized and value 1 indicates Distributed VRB assignment) while distributed virtual resource blocks are always assigned in case of resource allocation signalled with PDCCH DCI format 1C. Localized VRB allocations for a UE vary from a single VRB up to a maximum number of VRBs spanning the system bandwidth. For DCI format 1A the distributed VRB allocations for a UE vary from a single VRB up to $N_{\mathrm{VRB}}^{\mathrm{DL}}$ VRBs, where $N_{\mathrm{VRB}}^{\mathrm{DL}}$ is defined in [3], if the DCI CRC is scrambled by P-RNTI, RA-RNTI, or SI-RNTI. With PDCCH DCI format 1B, 1D with a CRC scrambled by C-RNTI, or with DCI format 1A with a CRC scrambled with C-RNTI, SPS C-RNTI or Temporary C-RNTI distributed VRB allocations for a UE vary from a single VRB up to $N_{\mathrm{VRB}}^{\mathrm{DL}}$ VRBs if $N_{\mathrm{RB}}^{\mathrm{DL}}$ is 6-49 and vary from a single VRB up to 16 if $N_{\mathrm{RB}}^{\mathrm{DL}}$ is 50-110. With PDCCH DCI format 1C, distributed VRB allocations for a UE vary from $N_{\mathrm{RB}}^{\mathrm{step}}$ VRB(s) up to $\lfloor N_{\mathrm{VRB}}^{\mathrm{DL}} / N_{\mathrm{RB}}^{\mathrm{step}} \rfloor \cdot N_{\mathrm{RB}}^{\mathrm{step}}$ VRBs with an increment step of $N_{\mathrm{RB}}^{\mathrm{step}}$, where $N_{\mathrm{RB}}^{\mathrm{step}}$ value is determined depending on the downlink system bandwidth as shown in Table 7.1.6.3-1.

Table 7.1.6.3-1: $N_{\mathrm{RB}}^{\mathrm{step}}$ values vs. Downlink System Bandwidth

System BW ($N_{\mathrm{RB}}^{\mathrm{DL}}$)	$N_{\mathrm{RB}}^{\mathrm{step}}$
	DCI format 1C
6-49	2
50-110	4

For PDCCH DCI format 1A, 1B or 1D, a type 2 resource allocation field consists of a resource indication value (*RIV*) corresponding to a starting resource block (RB_{start}) and a length in terms of virtually contiguously allocated resource blocks L_{CRBs} . The resource indication value is defined by

if $(L_{CRBs} - 1) \le \lfloor N_{RB}^{DL} / 2 \rfloor$ then

$$RIV = N_{RB}^{DL}(L_{CRBs} - 1) + RB_{start}$$

else

$$RIV = N_{RB}^{DL}(N_{RB}^{DL} - L_{CRBs} + 1) + (N_{RB}^{DL} - 1 - RB_{start})$$

where $L_{CRBs} \ge 1$ and shall not exceed $N_{VRB}^{DL} - RB_{start}$.

For PDCCH DCI format 1C, a type 2 resource block assignment field consists of a resource indication value (*RIV*) corresponding to a starting resource block ($RB_{start} = 0,\ N_{\mathrm{RB}}^{\mathrm{step}},\ 2N_{\mathrm{RB}}^{\mathrm{step}}, \ldots, (\lfloor N_{\mathrm{VRB}}^{\mathrm{DL}} / N_{\mathrm{RB}}^{\mathrm{step}} \rfloor - 1) N_{\mathrm{RB}}^{\mathrm{step}}$) and a length in terms of virtually contiguously allocated resource blocks ($L_{CRBs} = N_{\mathrm{RB}}^{\mathrm{step}},\ 2N_{\mathrm{RB}}^{\mathrm{step}}, \ldots, \lfloor N_{\mathrm{VRB}}^{\mathrm{DL}} / N_{\mathrm{RB}}^{\mathrm{step}} \rfloor \cdot N_{\mathrm{RB}}^{\mathrm{step}}$). The resource indication value is defined by

if $(L'_{CRBs} - 1) \le \lfloor N'^{DL}_{VRB} / 2 \rfloor$ then

$$RIV = N'^{DL}_{VRB}(L'_{CRBs} - 1) + RB'_{start}$$

else

$$RIV = N'^{DL}_{VRB}(N'^{DL}_{VRB} - L'_{CRBs} + 1) + (N'^{DL}_{VRB} - 1 - RB'_{start})$$

where $L'_{CRBs} = L_{CRBs} / N_{RB}^{step}$, $RB'_{start} = RB_{start} / N_{RB}^{step}$ and $N'^{DL}_{VRB} = \lfloor N_{VRB}^{DL} / N_{RB}^{step} \rfloor$. Here, $L'_{CRBs} \ge 1$ and shall not exceed $N'^{DL}_{VRB} - RB'_{start}$.

3GPP TS 36.213 (v 10.13.0) § 7.1.6.3.

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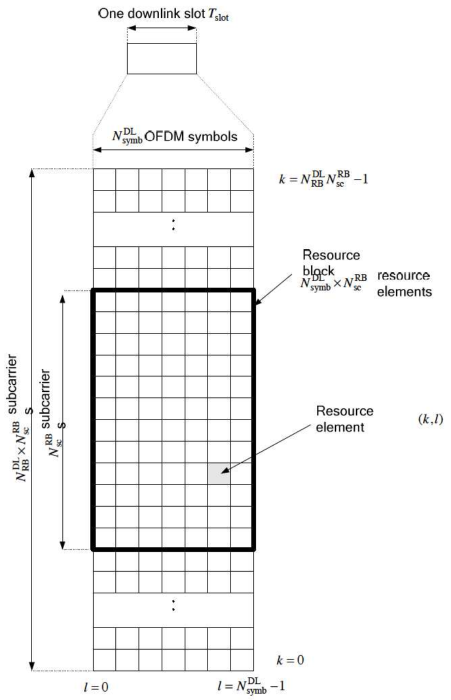

Figure 6.2.2-1: Downlink resource grid.

3GPP TS 36.211 (v 10.7.0) § 6.2.2.

Table 6.2.3-1: Physical resource blocks parameters.

Configuration		N_{sc}^{RB}	N_{symb}^{DL}
Normal cyclic prefix	$\Delta f = 15\,\mathrm{kHz}$	12	7
Extended cyclic prefix	$\Delta f = 15\,\mathrm{kHz}$		6
	$\Delta f = 7.5\,\mathrm{kHz}$	24	3

3GPP TS 36.211 (v 10.7.0) § 6.2.3.

132. The Nokia LTE Accused Products further comprise a second transmit chain configured to generate and transmit a burst-mode transmission in a second frequency band of the shared OFDM band in a second subset of the plurality of OFDM transmission intervals. As shown below, the corresponding functionality is described in the LTE-Advanced standard, including but not limited to 3GPP TS 36.101 (v 10.3.0) §§ 5.6 & 5.6A.1, 3GPP TS 36.211 (v 10.7.0) §§ 6.2.2, 6.2.3, 6.3 & 6.4, 3GPP TS 36.213 (v 10.13.0) §§ 7.1.6 & 7.1.6.1, and 3GPP TS 36.300 (v 10.12.0) §§ 5.5, 6.4, 7.5 & 11.1, as well as secondary materials on 3GPP's website.

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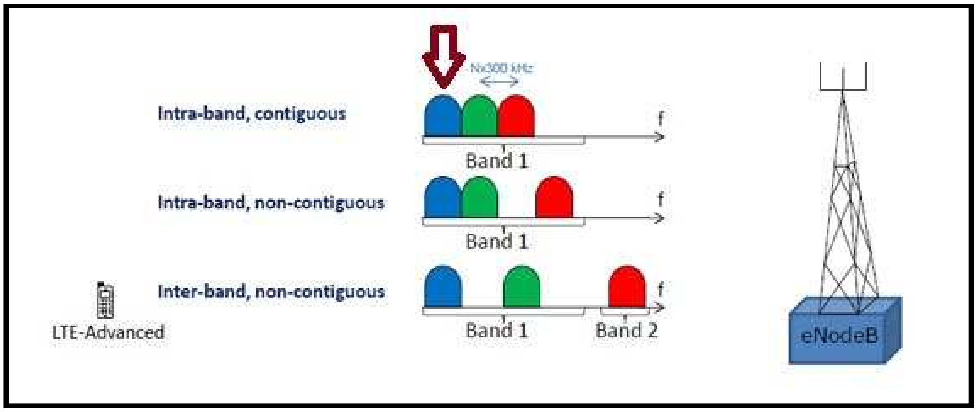
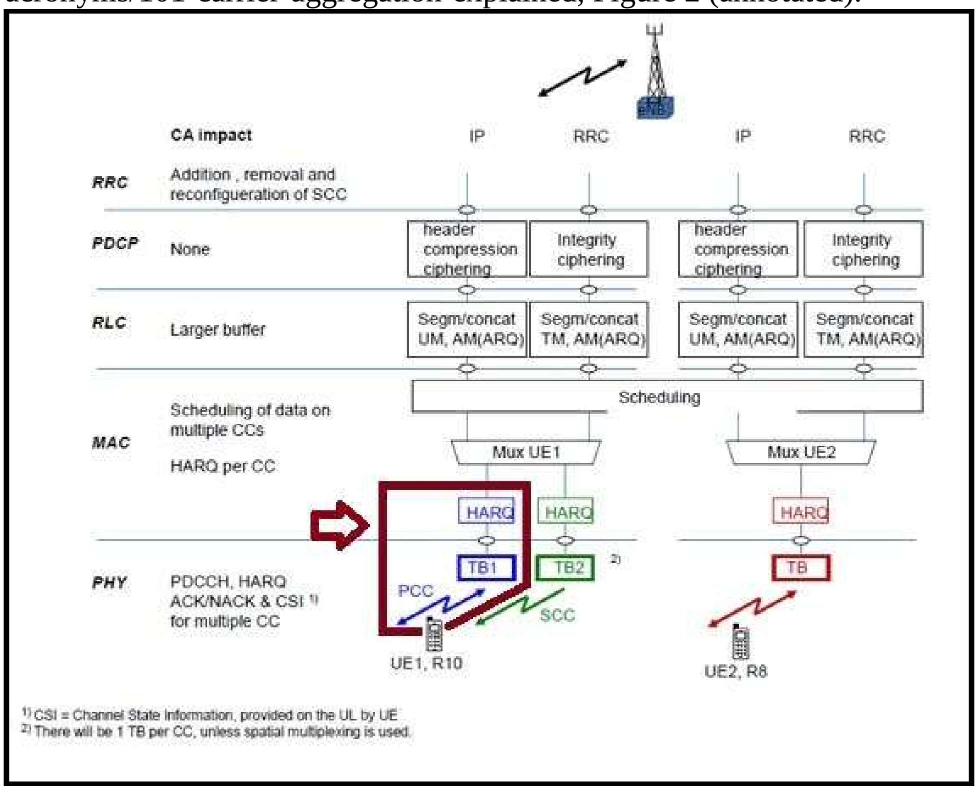


3GPP: Carrier Aggregation Explained, http://www.3gpp.org/technologies/keywords-acronyms/101-carrier-aggregation-explained, Figure 2 (annotated).



3GPP: Carrier Aggregation Explained, http://www.3gpp.org/technologies/keywords-acronyms/101-carrier-aggregation-explained, Figure 4 (annotated).

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6.3 General structure for downlink physical channels

This section describes a general structure, applicable to more than one physical channel.

The baseband signal representing a downlink physical channel is defined in terms of the following steps:

- scrambling of coded bits in each of the codewords to be transmitted on a physical channel
- modulation of scrambled bits to generate complex-valued modulation symbols
- mapping of the complex-valued modulation symbols onto one or several transmission layers
- precoding of the complex-valued modulation symbols on each layer for transmission on the antenna ports
- mapping of complex-valued modulation symbols for each antenna port to resource elements
- generation of complex-valued time-domain OFDM signal for each antenna port

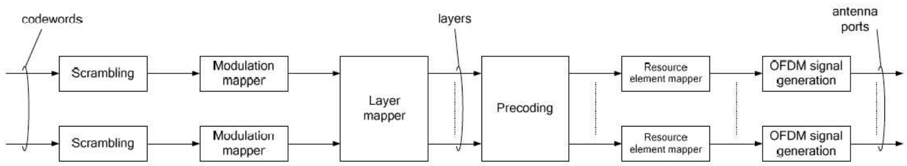

Figure 6.3-1: Overview of physical channel processing.

3GPP TS 36.211 (v 10.7.0) § 6.3.

6.4 Physical downlink shared channel

The physical downlink shared channel shall be processed and mapped to resource elements as described in Section 6.3 with the following exceptions:

- In resource blocks in which UE-specific reference signals are not transmitted, the PDSCH shall be transmitted on the same set of antenna ports as the PBCH, which is one of $\{0\}$, $\{0,1\}$, or $\{0,1,2,3\}$
- In resource blocks in which UE-specific reference signals are transmitted, the PDSCH shall be transmitted on antenna port(s) $\{5\}$, $\{7\}$, $\{8\}$, or $p \in \{7,8,...,\upsilon+6\}$, where υ is the number of layers used for transmission of the PDSCH.
- If PDSCH is transmitted in MBSFN subframes as defined in [4], the PDSCH shall be transmitted on one or several of antenna port(s) $p \in \{7,8,...,\upsilon+6\}$, where υ is the number of layers used for transmission of the PDSCH.

3GPP TS 36.211 (v 10.7.0) § 6.4.

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6.4 Carrier Aggregation

In case of CA, the multi-carrier nature of the physical layer is only exposed to the MAC layer for which one HARQ entity is required per serving cell;

- In both uplink and downlink, there is one independent hybrid-ARQ entity per serving cell and one transport block is generated per TTI per serving cell in the absence of spatial multiplexing. Each transport block and its potential HARQ retransmissions are mapped to a single serving cell.

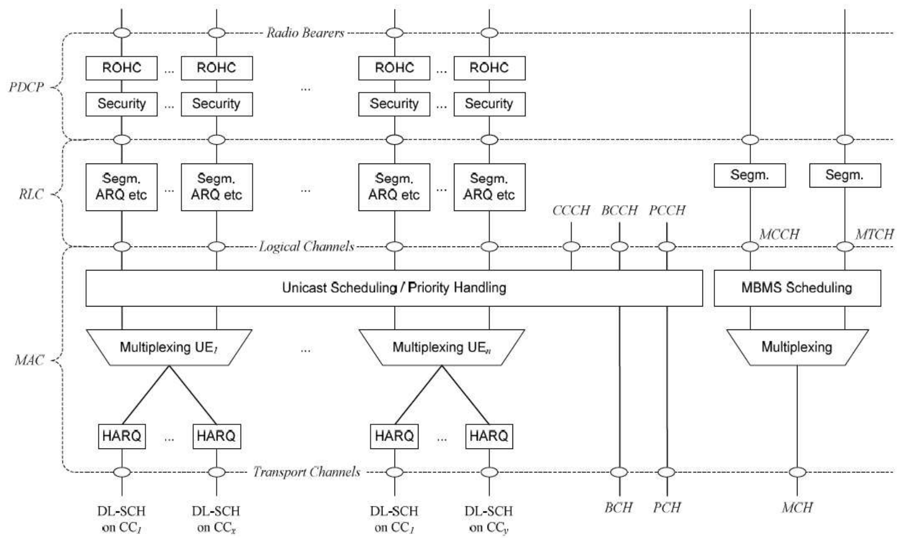

Figure 6.4-1: Layer 2 Structure for DL with CA configured

3GPP TS 36.300 (v 10.12.0) § 6.4.

5.5 Carrier Aggregation

In Carrier Aggregation (CA), two or more Component Carriers (CCs) are aggregated in order to support wider transmission bandwidths up to 100MHz. A UE may simultaneously receive or transmit on one or multiple CCs depending on its capabilities:

- A Rel-10 UE with reception and/or transmission capabilities for CA can simultaneously receive and/or transmit on multiple CCs corresponding to multiple serving cells;
- A Rel-8/9 UE can receive on a single CC and transmit on a single CC corresponding to one serving cell only.

CA is supported for both contiguous and non-contiguous CCs with each CC limited to a maximum of 110 Resource Blocks in the frequency domain using the Rel-8/9 numerology.

It is possible to configure a UE to aggregate a different number of CCs originating from the same eNB and of possibly different bandwidths in the UL and the DL.

3GPP TS 36.300 (v 10.12.0) § 5.5.

7.5 Carrier Aggregation

When CA is configured, the UE only has one RRC connection with the network. At RRC connection establishment/re-establishment/handover, one serving cell provides the NAS mobility information (e.g. TAI), and at RRC connection re-establishment/handover, one serving cell provides the security input. This cell is referred to as the Primary Cell (PCell). In the downlink, the carrier corresponding to the PCell is the Downlink Primary Component Carrier (DL PCC) while in the uplink it is the Uplink Primary Component Carrier (UL PCC).

Depending on UE capabilities, Secondary Cells (SCells) can be configured to form together with the PCell a set of serving cells. In the downlink, the carrier corresponding to an SCell is a Downlink Secondary Component Carrier (DL SCC) while in the uplink it is an Uplink Secondary Component Carrier (UL SCC).

The configured set of serving cells for a UE therefore always consists of one PCell and one or more SCells:

3GPP TS 36.300 (v 10.12.0) § 7.5.

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Radio resource allocations can be valid for one or multiple TTIs.

Resource assignment consists of physical resource blocks (PRB) and MCS. Allocations for time periods longer than one TTI might also require additional information (allocation time, allocation repetition factor…).

When CA is configured, a UE may be scheduled over multiple serving cells simultaneously but at most one random access procedure shall be ongoing at any time. Cross-carrier scheduling with the Carrier Indicator Field (CIF) allows the PDCCH of a serving cell to schedule resources on another serving cell but with the following restrictions:

- Cross-carrier scheduling does not apply to PCell i.e. PCell is always scheduled via its PDCCH;
- When the PDCCH of an SCell is configured, cross-carrier scheduling does not apply to this SCell i.e. it is always scheduled via its PDCCH;
- When the PDCCH of an SCell is not configured, cross-carrier scheduling applies and this SCell is always scheduled via the PDCCH of one other serving cell.

3GPP TS 36.300 (v 10.12.0) § 11.1.

5.6 Channel bandwidth

Requirements in present document are specified for the channel bandwidths listed in Table 5.6-1.

Table 5.6-1: Transmission bandwidth configuration N_{RB} in E-UTRA channel bandwidths

Channel bandwidth $BW_{Channel}$ [MHz]	1.4	3	5	10	15	20
Transmission bandwidth configuration N_{RB}	6	15	25	50	75	100

Figure 5.6-1 shows the relation between the Channel bandwidth ($BW_{Channel}$) and the Transmission bandwidth configuration (N_{RB}). The channel edges are defined as the lowest and highest frequencies of the carrier separated by the channel bandwidth, i.e. at F_C +/- $BW_{Channel}$ /2.

3GPP TS 36.101 (v 10.3.0) § 5.6.

5.6A.1 Channel bandwidths per operating band for CA

The requirements in this specification apply to the combination of CA bandwidth class and CA operating bands shown in Table 5.6A.1-1.

Indexing letter in CA configuration acronym refers to supported CA bandwidth class. In case no CA bandwidth class is labelled acronym refers to all specified combinations of CA bandwidth class and CA operating band. CA configuration refers to a combination of CA operating band and CA bandwidth class supported by a UE.

DL component carrier combinations for a given CA operating band shall be symmetrical in relation to channel centre unless stated otherwise in table 5.6A.1-1 or 5.6A.1-2.

Table 5.6A.1-1: Supported E-UTRA bandwidths per CA configuration for intra-band contiguous CA

CA operating band / channel bandwidth							
E-UTRA CA Configuration	E-UTRA Bands	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
CA_1C	1					Yes	Yes
CA_40C[1]	40				Yes	Yes	Yes
Note 1: Combinations of component carriers with unequal channel bandwidth should be considered. The maximum number of CCs for combination is two.							

Table 5.6A.1-2: Supported E-UTRA bandwidths per CA configuration for inter-band CA

CA operating / channel bandwidth							
E-UTRA CA Configuration	E-UTRA Bands	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
CA_1A-5A	1				Yes		
	5				Yes		

3GPP TS 36.101 (v 10.3.0) § 5.6A.1.

7.1.6 Resource allocation

The UE shall interpret the resource allocation field depending on the PDCCH DCI format detected. A resource allocation field in each PDCCH includes two parts, a resource allocation header field and information consisting of the actual resource block assignment. PDCCH DCI formats 1, 2, 2A, 2B and 2C with type 0 and PDCCH DCI formats 1, 2, 2A,2B and 2C with type 1 resource allocation have the same format and are distinguished from each other via the single bit resource allocation header field which exists depending on the downlink system bandwidth (subclause 5.3.3.1 of

[4]), where type 0 is indicated by 0 value and type 1 is indicated otherwise. PDCCH with DCI format 1A, 1B, 1C and 1D have a type 2 resource allocation while PDCCH with DCI format 1, 2, 2A, 2B and 2C have type 0 or type 1 resource allocation. PDCCH DCI formats with a type 2 resource allocation do not have a resource allocation header field.

3GPP TS 36.213 (v 10.13.0) § 7.1.6.

7.1.6.1 Resource allocation type 0

In resource allocations of type 0, resource block assignment information includes a bitmap indicating the resource block groups (RBGs) that are allocated to the scheduled UE where a RBG is a set of consecutive virtual resource blocks (VRBs) of localized type as defined in subclause 6.2.3.1 of [3]. Resource block group size (*P*) is a function of the system bandwidth as shown in Table 7.1.6.1-1. The total number of RBGs (N_{RBG}) for downlink system bandwidth of $N_{\mathrm{RB}}^{\mathrm{DL}}$ is given by $N_{RBG} = \lceil N_{\mathrm{RB}}^{\mathrm{DL}} / P \rceil$ where $\lfloor N_{\mathrm{RB}}^{\mathrm{DL}} / P \rfloor$ of the RBGs are of size P and if $N_{\mathrm{RB}}^{\mathrm{DL}} \bmod P > 0$ then one of the RBGs is of size $N_{\mathrm{RB}}^{\mathrm{DL}} - P \cdot \lfloor N_{\mathrm{RB}}^{\mathrm{DL}} / P \rfloor$. The bitmap is of size N_{RBG} bits with one bitmap bit per RBG such that each RBG is addressable. The RBGs shall be indexed in the order of increasing frequency and non-increasing RBG sizes starting at the lowest frequency. The order of RBG to bitmap bit mapping is in such way that RBG 0 to RBG $N_{\mathrm{RBG}} - 1$ are mapped to MSB to LSB of the bitmap. The RBG is allocated to the UE if the corresponding bit value in the bitmap is 1, the RBG is not allocated to the UE otherwise.

Table 7.1.6.1-1: Type 0 Resource Allocation RBG Size vs. Downlink System Bandwidth

System Bandwidth $N_{\mathrm{RB}}^{\mathrm{DL}}$	RBG Size (*P*)
≤10	1
11 – 26	2
27 – 63	3
64 – 110	4

3GPP TS 36.213 (v 10.13.0) § 7.1.6.1.

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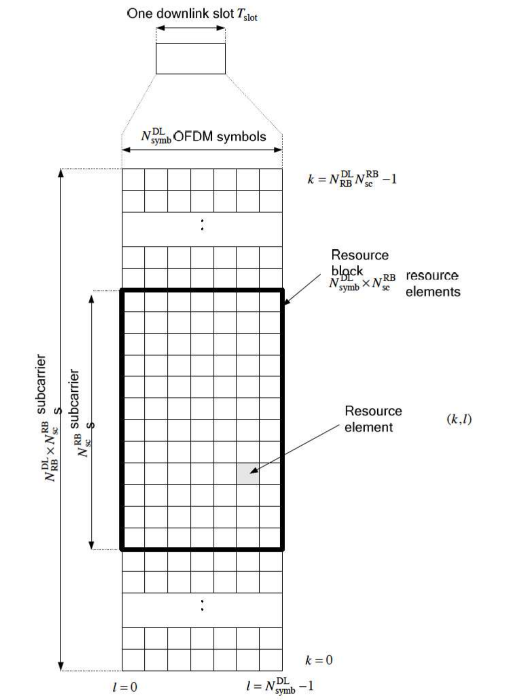

Figure 6.2.2-1: Downlink resource grid.

3GPP TS 36.211 (v 10.7.0) § 6.2.2.

Table 6.2.3-1: Physical resource blocks parameters.

Configuration		$N_{\text{sc}}^{\text{RB}}$	$N_{\text{symb}}^{\text{DL}}$
Normal cyclic prefix	$\Delta f = 15\,\text{kHz}$	12	7
Extended cyclic prefix	$\Delta f = 15\,\text{kHz}$		6
	$\Delta f = 7.5\,\text{kHz}$	24	3

3GPP TS 36.211 (v 10.7.0) § 6.2.3.

133. The Nokia LTE Accused Products further comprise a wireless terminal in which the first subset of the plurality of OFDM transmission intervals have at least one OFDM transmission interval in common with the second subset of the plurality of OFDM transmission intervals. As shown below, the corresponding functionality is described in the LTE-Advanced standard, including but not limited to 3GPP TS 36.300 (v 10.12.0) §§ 5.5 & 11.1.

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5.5 Carrier Aggregation

In Carrier Aggregation (CA), two or more Component Carriers (CCs) are aggregated in order to support wider transmission bandwidths up to 100MHz. A UE may simultaneously receive or transmit on one or multiple CCs depending on its capabilities:

- A Rel-10 UE with reception and/or transmission capabilities for CA can simultaneously receive and/or transmit on multiple CCs corresponding to multiple serving cells;
- A Rel-8/9 UE can receive on a single CC and transmit on a single CC corresponding to one serving cell only.

CA is supported for both contiguous and non-contiguous CCs with each CC limited to a maximum of 110 Resource Blocks in the frequency domain using the Rel-8/9 numerology.

It is possible to configure a UE to aggregate a different number of CCs originating from the same eNB and of possibly different bandwidths in the UL and the DL.

3GPP TS 36.300 (v 10.12.0) § 5.5.

11.1 Basic Scheduler Operation

MAC in eNB includes dynamic resource schedulers that allocate physical layer resources for the DL-SCH and UL-SCH transport channels. Different schedulers operate for the DL-SCH and UL-SCH.

The scheduler should take account of the traffic volume and the QoS requirements of each UE and associated radio bearers, when sharing resources between UEs. Only "per UE" grants are used to grant the right to transmit on the UL-SCH (i.e. there are no "per UE per RB" grants).

Schedulers may assign resources taking account the radio conditions at the UE identified through measurements made at the eNB and/or reported by the UE.

Radio resource allocations can be valid for one or multiple TTIs.

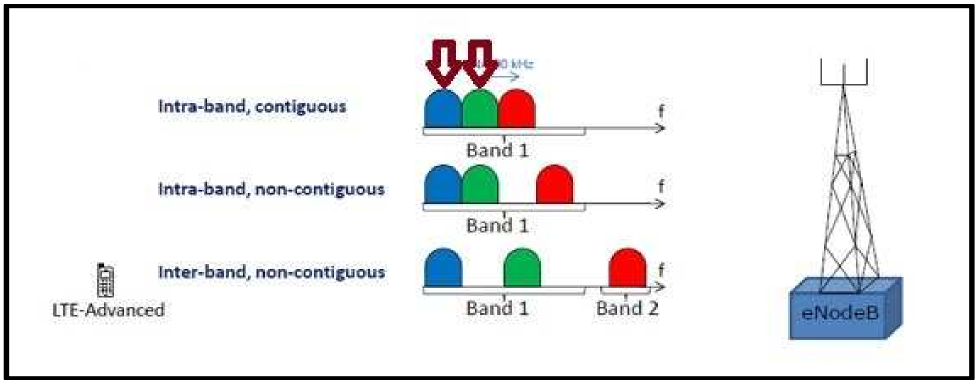
Resource assignment consists of physical resource blocks (PRB) and MCS. Allocations for time periods longer than one TTI might also require additional information (allocation time, allocation repetition factor…).

When CA is configured, a UE may be scheduled over multiple serving cells simultaneously but at most one random access procedure shall be ongoing at any time. Cross-carrier scheduling with the Carrier Indicator Field (CIF) allows the PDCCH of a serving cell to schedule resources on another serving cell but with the following restrictions:

- Cross-carrier scheduling does not apply to PCell i.e. PCell is always scheduled via its PDCCH;
- When the PDCCH of an SCell is configured, cross-carrier scheduling does not apply to this SCell i.e. it is always scheduled via its PDCCH;
- When the PDCCH of an SCell is not configured, cross-carrier scheduling applies and this SCell is always scheduled via the PDCCH of one other serving cell.

3GPP TS 36.300 (v 10.12.0) § 11.1.

134. The Nokia LTE Accused Products further comprise a wireless terminal wherein for the at least one OFDM transmission interval common between the first subset and the second subset, the first frequency band is non-overlapping in frequency with the second frequency band. As shown below, the corresponding functionality is part of the LTE-Advanced standard as described in materials on 3GPP's website.



3GPP: Carrier Aggregation Explained, http://www.3gpp.org/technologies/keywords-acronyms/101-carrier-aggregation-explained, Figure 2 (annotated).

135. Thus, as described above, the Nokia LTE Accused Products infringe one or more claims of the ’546 Patent, including claim 1.

B. Nokia’s Infringement of the ’814 Apple LTE Patent.

136. By way of example, and as shown below, the Nokia LTE Accused Products infringe at least claim 1 of the ’814 Patent because they comply with the relevant portions of the LTE-Advanced standard. For example, on information and belief, the Nokia LTE Accused Products comprise a transmitter with a demultiplexer and a plurality of orthogonal frequency division multiplexing (OFDM) components each receiving demultiplexed data from the demultiplexer. As shown below, the corresponding functionality is described in the LTE-Advanced standard, including but not limited to 3GPP TS 36.300 (v 8.12.0) §§ 5.1.1 & 5.1.5 and 3GPP TS 36.211 (v 8.9.0) §§ 6.2.2, 6.2.3, 6.3 & 6.3.5.

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5.1 Downlink Transmission Scheme

5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

In addition there is also a reduced sub-carrier spacingΔf_{low} = 7.5 kHz, only for MBMS-dedicated cell.

In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (OFDM symbol #0) , $T_{CP} = 144 \times Ts$ (OFDM symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (OFDM symbol #0 to OFDM symbol #5)

  where $T_s = 1/(2048 \times \Delta f)$

In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low} = 1024 \times Ts$, corresponding to 3 OFDM symbols per slot.

In case of FDD, operation with half duplex from UE point of view is supported.

3GPP TS 36.300 (v 8.12.0) § 5.1.1.

5.1.5 Downlink multi-antenna transmission

Multi-antenna transmission with 2 and 4 transmit antennas is supported. The maximum number of codeword is two irrespective to the number of antennas with fixed mapping between code words to layers.

Spatial division multiplexing (SDM) of multiple modulation symbol streams to a single UE using the same time-frequency (-code) resource, also referred to as Single-User MIMO (SU-MIMO) is supported. When a MIMO channel is solely assigned to a single UE, it is known as SU-MIMO. Spatial division multiplexing of modulation symbol streams to different UEs using the same time-frequency resource, also referred to as MU-MIMO, is also supported. There is semi-static switching between SU-MIMO and MU-MIMO per UE.

3GPP TS 36.300 (v 8.12.0) § 5.1.5.

6.2.2 Resource elements

Each element in the resource grid for antenna port p is called a resource element and is uniquely identified by the index pair (k,l) in a slot where $k = 0,...,N_{RB}^{DL}N_{sc}^{RB} - 1$ and $l = 0,...,N_{symb}^{DL} - 1$ are the indices in the frequency and time domains, respectively. Resource element (k,l) on antenna port p corresponds to the complex value $a_{k,l}^{(p)}$. When there is no risk for confusion, or no particular antenna port is specified, the index p may be dropped.

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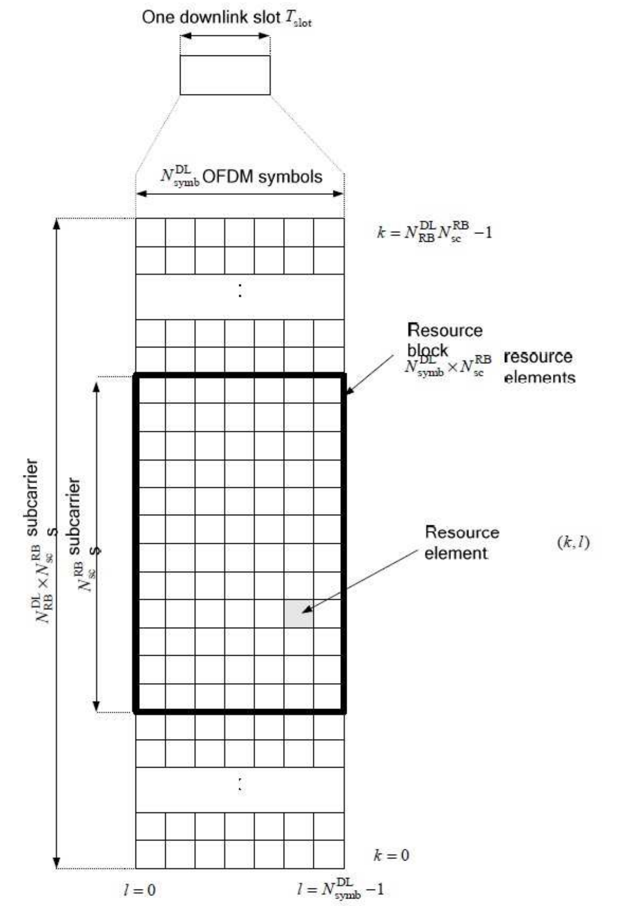

Figure 6.2.2-1: Downlink resource grid.

3GPP TS 36.211 (v 8.9.0) § 6.2.2.

6.2.3 Resource blocks

Resource blocks are used to describe the mapping of certain physical channels to resource elements. Physical and virtual resource blocks are defined.

A physical resource block is defined as $N_{\text{symb}}^{\text{DL}}$ consecutive OFDM symbols in the time domain and $N_{\text{sc}}^{\text{RB}}$ consecutive subcarriers in the frequency domain, where $N_{\text{symb}}^{\text{DL}}$ and $N_{\text{sc}}^{\text{RB}}$ are given by Table 6.2.3-1. A physical resource block thus consists of $N_{\text{symb}}^{\text{DL}} \times N_{\text{sc}}^{\text{RB}}$ resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Physical resource blocks are numbered from 0 to $N_{\text{RB}}^{\text{DL}} - 1$ in the frequency domain. The relation between the physical resource block number n_{PRB} in the frequency domain and resource elements (k,l) in a slot is given by

$$n_{\text{PRB}} = \left\lfloor \frac{k}{N_{\text{sc}}^{\text{RB}}} \right\rfloor$$

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Table 6.2.3-1: Physical resource blocks parameters.

Configuration		N_{sc}^{RB}	N_{symb}^{DL}
Normal cyclic prefix	$\Delta f = 15\,\text{kHz}$	12	7
Extended cyclic prefix	$\Delta f = 15\,\text{kHz}$		6
	$\Delta f = 7.5\,\text{kHz}$	24	3

A virtual resource block is of the same size as a physical resource block. Two types of virtual resource blocks are defined:

- Virtual resource blocks of localized type
- Virtual resource blocks of distributed type

For each type of virtual resource blocks, a pair of virtual resource blocks over two slots in a subframe is assigned together by a single virtual resource block number, n_{VRB}.

3GPP TS 36.211 (v 8.9.0) § 6.2.3.

6.3 General structure for downlink physical channels

This section describes a general structure, applicable to more than one physical channel.

The baseband signal representing a downlink physical channel is defined in terms of the following steps:

- scrambling of coded bits in each of the code words to be transmitted on a physical channel
- modulation of scrambled bits to generate complex-valued modulation symbols
- mapping of the complex-valued modulation symbols onto one or several transmission layers
- precoding of the complex-valued modulation symbols on each layer for transmission on the antenna ports
- mapping of complex-valued modulation symbols for each antenna port to resource elements
- generation of complex-valued time-domain OFDM signal for each antenna port

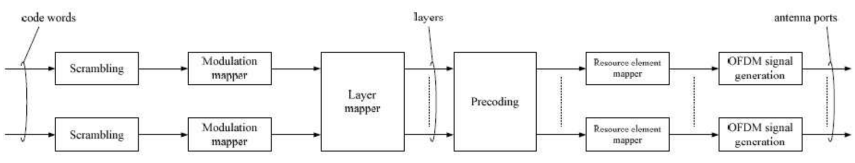

Figure 6.3-1: Overview of physical channel processing.

3GPP TS 36.211 (v 8.9.0) § 6.3.

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6.3.5 Mapping to resource elements

For each of the antenna ports used for transmission of the physical channel, the block of complex-valued symbols $y^{(p)}(0),...,y^{(p)}(M_{\text{symb}}^{\text{ap}}-1)$ shall be mapped in sequence starting with $y^{(p)}(0)$ to resource elements (k,l) which meet all of the following criteria:

-they are in the physical resource blocks corresponding to the virtual resource blocks assigned for transmission, and

-they are not used for transmission of PBCH, synchronization signals or reference signals, and

-they are not in an OFDM symbol used for PDCCH as defined in section 6.7.

The mapping to resource elements (k,l) on antenna port p not reserved for other purposes shall be in increasing order of first the index k over the assigned physical resource blocks and then the index l, starting with the first slot in a subframe.

3GPP TS 36.211 (v 8.9.0) § 6.3.5.

137. The Nokia LTE Accused Products further comprise a plurality of antennas. On information and belief, each antenna is connected to a respective OFDM component of the plurality of OFDM components. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.300 (v 8.12.0) §§ 5.1.1 & 5.1.5.

5.1 Downlink Transmission Scheme

5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell.

In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (OFDM symbol #0) , $T_{CP} = 144 \times Ts$ (OFDM symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (OFDM symbol #0 to OFDM symbol #5)

  where $T_s = 1/(2048 \times \Delta f)$

In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low} = 1024 \times Ts$, corresponding to 3 OFDM symbols per slot.

In case of FDD, operation with half duplex from UE point of view is supported.

3GPP TS 36.300 (v 8.12.0) § 5.1.1.

5.1.5 Downlink multi-antenna transmission

Multi-antenna transmission with 2 and 4 transmit antennas is supported. The maximum number of codeword is two irrespective to the number of antennas with fixed mapping between code words to layers.

Spatial division multiplexing (SDM) of multiple modulation symbol streams to a single UE using the same time-frequency (-code) resource, also referred to as Single-User MIMO (SU-MIMO) is supported. When a MIMO channel is solely assigned to a single UE, it is known as SU-MIMO. Spatial division multiplexing of modulation symbol streams to different UEs using the same time-frequency resource, also referred to as MU-MIMO, is also supported. There is semi-static switching between SU-MIMO and MU-MIMO per UE.

3GPP TS 36.300 (v 8.12.0) § 5.1.5.

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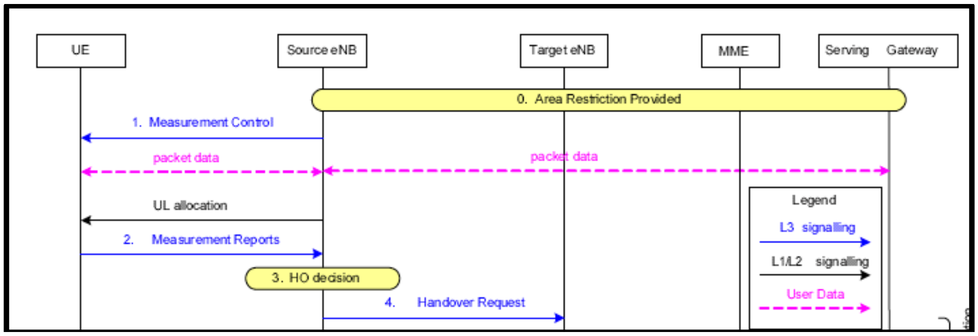
138. The Nokia LTE Accused Products comprise a transmitter adapted to transmit a packet data frame structure. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.300 (v 8.12.0) §§ 5 & 10.1.2.1.1.



3GPP TS 36.300 (v 8.12.0) § 10.1.2.1.1.

5 Physical Layer for E-UTRA

Downlink and uplink transmissions are organized into radio frames with 10 ms duration. Two radio frame structures are supported:

- Type 1, applicable to FDD,
- Type 2, applicable to TDD.

Frame structure Type 1 is illustrated in Figure 5.1-1. Each 10 ms radio frame is divided into ten equally sized sub-frames. Each sub-frame consists of two equally sized slots. For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain.

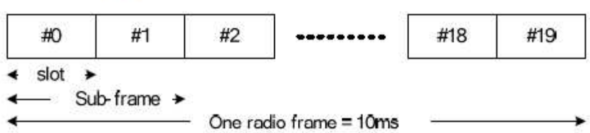


Figure 5.1-1: Frame structure type 1

3GPP TS 36.300 (v 8.12.0) § 5.

139. The Nokia LTE Accused Products comprise a transmitter further adapted to transmit a packet data frame structure comprising a superframe having a length corresponding to a synchronization period of a network, the superframe containing a plurality of radio frames. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.300 (v 8.12.0) §§ 5 & 7.4, 3GPP TS 36.321 (v 8.12.0) § 5.10, and 3GPP TS 36.331 (v 8.21.0) §§ 5.2.1, 5.2.1.3, 5.2.3, 6.2.1 & pp. 100–102.

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5.2.1 Introduction

5.2.1.1 General

System information is divided into the *MasterInformationBlock* (MIB) and a number of *SystemInformationBlocks* (SIBs). The MIB includes a limited number of most essential and most frequently transmitted parameters that are needed to acquire other information from the cell, and is transmitted on BCH. SIBs other than *SystemInformationBlockType1* are carried in *SystemInformation* (SI) messages and mapping of SIBs to SI messages is flexibly configurable by *schedulingInfoList* included in *SystemInformationBlockType1*, with restrictions that: each SIB is contained only in a single SI message, only SIBs having the same scheduling requirement (periodicity) can be mapped to the same SI message, and *SystemInformationBlockType2* is always mapped to the SI message that corresponds to the first entry in the list of SI messages in *schedulingInfoList*. There may be multiple SI messages transmitted with the same periodicity. *SystemInformationBlockType1* and all SI messages are transmitted on DL-SCH.

5.2.1.2 Scheduling

The MIB uses a fixed schedule with a periodicity of 40 ms and repetitions made within 40 ms. The first transmission of the MIB is scheduled in subframe #0 of radio frames for which the SFN mod 4 = 0, and repetitions are scheduled in subframe #0 of all other radio frames.

3GPP TS 36.331 (v 8.21.0) § 5.2.1.

7.4 System Information

System information is divided into the *MasterInformationBlock* (MIB) and a number of *SystemInformationBlocks* (SIBs):

- *MasterInformationBlock* defines the most essential physical layer information of the cell required to receive further system information;
- *SystemInformationBlockType1* contains information relevant when evaluating if a UE is allowed to access a cell and defines the scheduling of other system information blocks;
- *SystemInformationBlockType2* contains common and shared channel information;
- *SystemInformationBlockType3* contains cell re-selection information, mainly related to the serving cell;
- *SystemInformationBlockType4* contains information about the serving frequency and intra-frequency neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters);
- *SystemInformationBlockType5* contains information about other E-UTRA frequencies and inter-frequency neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters);
- *SystemInformationBlockType6* contains information about UTRA frequencies and UTRA neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters);
- *SystemInformationBlockType7* contains information about GERAN frequencies relevant for cell re-selection (including cell re-selection parameters for each frequency);
- *SystemInformationBlockType8* contains information about CDMA2000 frequencies and CDMA2000 neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters);
- *SystemInformationBlockType9* contains a home eNB identifier (HNBID);
- *SystemInformationBlockType10* contains an ETWS primary notification;
- *SystemInformationBlockType11* contains an ETWS secondary notification.

The MIB is mapped on the BCCH and carried on BCH while all other SI messages are mapped on the BCCH and dynamically carried on DL-SCH where they can be identified through the SI-RNTI (System Information RNTI). Both the MIBand *SystemInformationBlockType1*use a fixed schedule with a periodicity of 40 and 80 ms respectively while the scheduling of other SI messages is flexible and indicated by *SystemInformationBlockType1*.

3GPP TS 36.300 (v 8.12.0) § 7.4.

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Physical broadcast channel (PBCH)

- The coded BCH transport block is mapped to four subframes within a 40 ms interval;
- 40 ms timing is blindly detected, i.e. there is no explicit signalling indicating 40 ms timing;
- Each subframe is assumed to be self-decodable, i.e. the BCH can be decoded from a single reception, assuming sufficiently good channel conditions.

3GPP TS 36.300 (v 8.12.0) § 5.

5.2.1.3 System information validity and notification of changes

Change of system information (other than for ETWS) only occurs at specific radio frames, i.e. the concept of a modification period is used. System information may be transmitted a number of times with the same content within a modification period, as defined by its scheduling. The modification period boundaries are defined by SFN values for which SFN mod *m*= 0, where *m* is the number of radio frames comprising the modification period. The modification period is configured by system information.

When the network changes (some of the) system information, it first notifies the UEs about this change, i.e. this may be done throughout a modification period. In the next modification period, the network transmits the updated system information. These general principles are illustrated in figure 5.2.1.3-1, in which different colours indicate different system information. Upon receiving a change notification, the UE acquires the new system information immediately from the start of the next modification period. The UE applies the previously acquired system information until the UE acquires the new system information.

3GPP TS 36.331 (v 8.21.0) § 5.2.1.3.

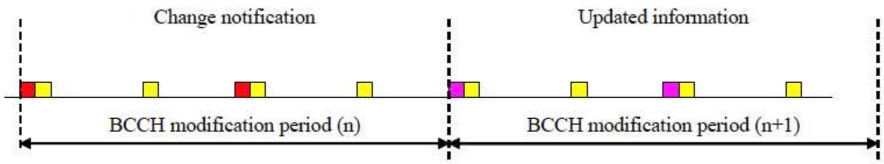

Figure 5.2.1.3-1: Change of system Information

3GPP TS 36.331 (v 8.21.0) § 5.2.1.3.

MasterInformationBlock

```
-- ASN1START

MasterInformationBlock ::=          SEQUENCE {
    dl-Bandwidth                        ENUMERATED {
                                            n6, n15, n25, n50, n75, n100},
    phich-Config                        PHICH-Config,
    systemFrameNumber                   BIT STRING (SIZE (8)),
    spare                               BIT STRING (SIZE (10))
}

-- ASN1STOP
```

MasterInformationBlock **field descriptions**
dl-Bandwidth Parameter: transmission bandwidth configuration, N_{RB} in downlink, see TS 36.101 [42, table 5.6-1]. n6 corresponds to 6 resource blocks, n15 to 15 resource blocks and so on.
systemFrameNumber Defines the 8 most significant bits of the SFN, see TS 36.211 [21, 6.6.1]. The 2 least significant bits of the SFN are acquired implicitly in the P-BCH decoding, i.e. timing of 40ms P-BCH TTI indicates 2 least significant bits (within 40ms P-BCH TTI, the first radio frame: 00, the second radio frame: 01, the third radio frame: 10, the last radio frame: 11).

3GPP TS 36.331 (v 8.21.0) § 6.2.1.

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5.10.1 Downlink

After a Semi-Persistent downlink assignment is configured, the UE shall consider that the assignment recurs in each subframe for which:

- (10 * SFN + subframe) = [(10 * $SFN_{start\ time}$ + $subframe_{start\ time}$) + N * *semiPersistSchedIntervalDL*] modulo 10240, for all N>0.

Where $SFN_{start\ time}$ and $subframe_{start\ time}$ are the SFN and subframe, respectively, at the time the configured downlink assignment were (re-)initialised.

5.10.2 Uplink

After a Semi-Persistent Scheduling uplink grant is configured, the UE shall:

- if *twoIntervalsConfig* is enabled by upper layer:
  - set the Subframe_Offset according to Table 7.4-1.
- else:
  - set Subframe_Offset to 0.
- consider that the grant recurs in each subframe for which:
  - (10 * SFN + subframe) = [(10 * $SFN_{start\ time}$ + $subframe_{start\ time}$) + N * *semiPersistSchedIntervalUL* + Subframe_Offset * (N modulo 2)] modulo 10240, for all N>0.

Where $SFN_{start\ time}$ and $subframe_{start\ time}$ are the SFN and subframe, respectively, at the time the configured uplink grant were (re-)initialised.

3GPP TS 36.321 (v 8.12.0) § 5.10.

```
SchedulingInfo ::=  SEQUENCE {
    si-Periodicity                      ENUMERATED {
                                            rf8, rf16, rf32, rf64, rf128, rf256, rf512},
    sib-MappingInfo                     SIB-MappingInfo
}
```

si-Periodicity Periodicity of the SI-message in radio frames, such that rf8 denotes 8 radio frames, rf16 denotes 16 radio frames, and so on.

3GPP TS 36.331 (v 8.21.0) at 100–102.

5.2.3 Acquisition of an SI message

When acquiring an SI message, the UE shall:

1> determine the start of the SI-window for the concerned SI message as follows:

2> for the concerned SI message, determine the number *n* which corresponds to the order of entry in the list of SI messages configured by *schedulingInfoList* in *SystemInformationBlockType1*;

2> determine the integer value $x = (n – 1)*w$, where w is the *si-WindowLength*;

2> the SI-window starts at the subframe #*a*, where $a = x$ mod 10, in the radio frame for which SFN mod T = FLOOR(x/10), where T is the *si-Periodicity* of the concerned SI message;

NOTE: E-UTRAN should configure an SI-window of 1 ms only if all SIs are scheduled before subframe #5 in radio frames for which SFN mod 2 = 0.

1> receive DL-SCH using the SI-RNTI from the start of the SI-window and continue until the end of the SI-window whose absolute length in time is given by *si-WindowLength*, or until the SI message was received, excluding the following subframes:

2> subframe #5 in radio frames for which SFN mod 2 = 0;

2> any MBSFN subframes;

2> any uplink subframes in TDD;

1> if the SI message was not received by the end of the SI-window, repeat reception at the next SI-window occasion for the concerned SI message;

3GPP TS 36.331 (v 8.21.0) § 5.2.3.

140. The Nokia LTE Accused Products comprise a transmitter further adapted to transmit a packet data frame structure in which each radio frame contains a plurality of TPS (transmission parameter signaling) frames corresponding to an adaptive coding and modulation period. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.211 (v8.9.0) §§ 4.1 & 6.8, 3GPP TS 36.212 (v 8.8.0) § 5.3.3.1.3A & 7.1.7, and 3GPP TS 36.300 (v 8.12.0) §§ 5 & 11.1.1.

11.1.1 Downlink Scheduling

In the downlink, E-UTRAN can dynamically allocate resources (PRBs and MCS) to UEs at each TTI via the C-RNTI on L1/L2 control channel(s). A UE always monitors the L1/L2 control channel(s) in order to find possible allocation when its downlink reception is enabled (activity governed by DRX).

See, *e.g.*, 3GPP TS 36.300 v 8.12.0 § 11.1.1.

5 Physical Layer for E-UTRA

Downlink and uplink transmissions are organized into radio frames with 10 ms duration. Two radio frame structures are supported:

- Type 1, applicable to FDD,
- Type 2, applicable to TDD.

Frame structure Type 1 is illustrated in Figure 5.1-1. Each 10 ms radio frame is divided into ten equally sized sub-frames. Each sub-frame consists of two equally sized slots. For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain.

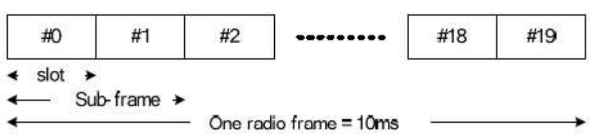

Figure 5.1-1: Frame structure type 1

3GPP TS 36.300 (v 8.12.0) § 5.

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4.1 Frame structure type 1

Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\,\text{ms}$ long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5\,\text{ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

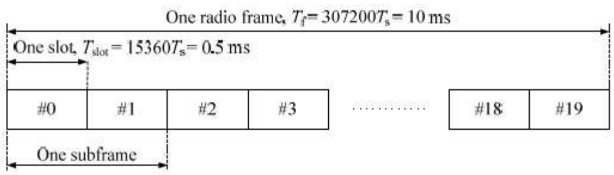

Figure 4.1-1: Frame structure type 1.

3GPP TS 36.211 (v 8.9.0) § 4.1.

6.8 Physical downlink control channel

6.8.1 PDCCH formats

The physical downlink control channel carries scheduling assignments and other control information. A physical control channel is transmitted on an aggregation of one or several consecutive control channel elements (CCEs), where a control channel element corresponds to 9 resource element groups. The number of resource-element groups not assigned to PCFICH or PHICH is N_{REG}. The CCEs available in the system are numbered from 0 to $N_{CCE} - 1$, where $N_{CCE} = \lfloor N_{REG}/9 \rfloor$. The PDCCH supports multiple formats as listed in Table 6.8.1-1. A PDCCH consisting of n consecutive CCEs may only start on a CCE fulfilling $i \bmod n = 0$, where i is the CCE number.

Multiple PDCCHs can be transmitted in a subframe.

Table 6.8.1-1: Supported PDCCH formats.

PDCCH format	Number of CCEs	Number of resource-element groups	Number of PDCCH bits
0	1	9	72
1	2	18	144
2	4	36	288
3	8	72	576

3GPP TS 36.211 (v 8.9.0) § 6.8.

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5.3.3.1.3A Format 1B

DCI format 1B is used for the compact scheduling of one PDSCH codeword with precoding information.

The following information is transmitted by means of the DCI format 1B:

- Localized/Distributed VRB assignment flag – 1 bit as defined in 7.1.6.3 of [3]
- Resource block assignment – $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits as defined in 7.1.6.3 of [3]
  - For localized VRB:

    $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits provide the resource allocation
  - For distributed VRB:
    - For $N_{RB}^{DL} < 50$
      - $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits provide the resource allocation
    - For $N_{RB}^{DL} \geq 50$
      - 1 bit, the MSB indicates the gap value, where value 0 indicates $N_{gap} = N_{gap,1}$ and value 1 indicates $N_{gap} = N_{gap,2}$
      - $(\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil - 1)$ bits provide the resource allocation
- Modulation and coding scheme – 5bits as defined in section 7.1.7 of [3]
- HARQ process number – 3 bits (FDD) , 4 bits (TDD)
- New data indicator – 1 bit
- Redundancy version – 2 bits

3GPP TS 36.212 (v 8.8.0) § 5.3.3.1.3A.

7.1.7 Modulation order and transport block size determination

To determine the modulation order and transport block size(s) in the physical downlink shared channel, the UE shall first

– read the 5-bit 'modulation and coding scheme' field (I_{MCS}) in the DCI, and

– compute the total number of allocated PRBs (N_{PRB}) based on the procedure defined in Section 7.1.6.

The UE may skip decoding a transport block in an initial transmission if the effective channel code rate is higher than 0.92, where the effective channel code rate is defined as the number of downlink information bits (including CRC bits) divided by the number of physical channel bits on PDSCH.

3GPP TS 36.213 (v 8.8.0) § 7.1.7.

141. The Nokia LTE Accused Products comprise a transmitter further adapted to transmit a packet data frame structure in which each TPS frame contains a plurality of slots corresponding to an air interface slot size and each slot contains a plurality of OFDM symbols. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.211 (v 8.9.0) §§ 4.1 & 6.2.2 and 3GPP TS 36.300 (v 8.12.0) §§ 5 & 5.1.

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5 Physical Layer for E-UTRA

Downlink and uplink transmissions are organized into radio frames with 10 ms duration. Two radio frame structures are supported:

- Type 1, applicable to FDD,
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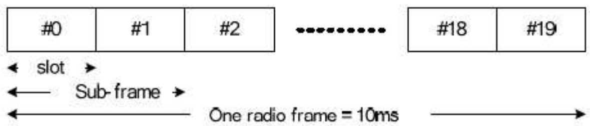

Figure 5.1-1: Frame structure type 1

3GPP TS 36.300 (v 8.12.0) § 5.

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Frame structure type 1 is applicable to both full duplex and half duplex FDD. Each radio frame is $T_f = 307200 \cdot T_s = 10\,\text{ms}$ long and consists of 20 slots of length $T_{slot} = 15360 \cdot T_s = 0.5\,\text{ms}$, numbered from 0 to 19. A subframe is defined as two consecutive slots where subframe i consists of slots $2i$ and $2i+1$.

For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain. In half-duplex FDD operation, the UE cannot transmit and receive at the same time while there are no such restrictions in full-duplex FDD.

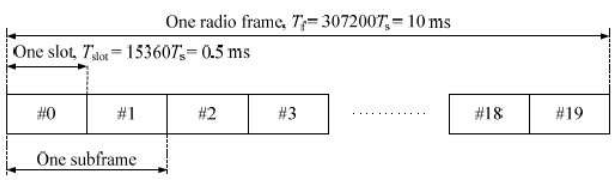

Figure 4.1-1: Frame structure type 1.

3GPP TS 36.211 (v 8.9.0) § 4.1.

5.1 Downlink Transmission Scheme

5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell.

In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (OFDM symbol #0) , $T_{CP} = 144 \times Ts$ (OFDM symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (OFDM symbol #0 to OFDM symbol #5)

  where $T_s = 1/(2048 \times \Delta f)$

In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low} = 1024 \times Ts$, corresponding to 3 OFDM symbols per slot.

In case of FDD, operation with half duplex from UE point of view is supported.

3GPP TS 36.300 (v 8.12.0) § 5.1.

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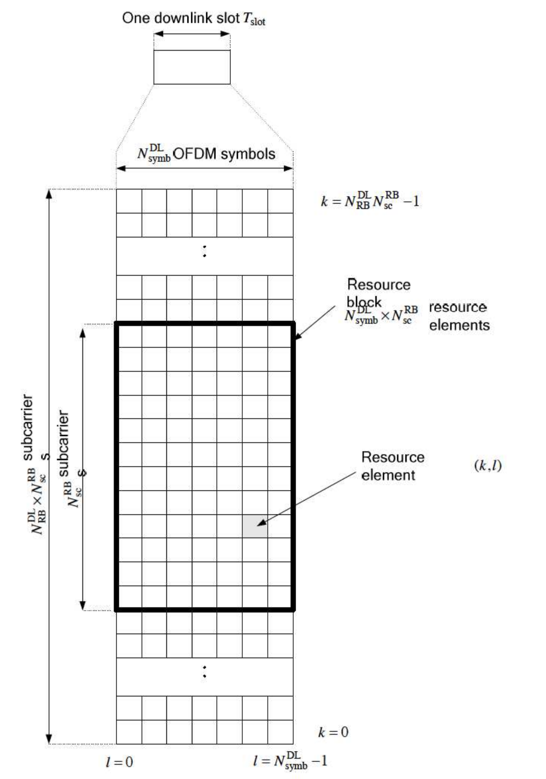

Figure 6.2.2-1: Downlink resource grid.

3GPP TS 36.211 (v 8.9.0) § 6.2.2.

142. The Nokia LTE Accused Products comprise a transmitter wherein the transmitter is adapted to transmit in a plurality of different modes by transmitting a different number of OFDM symbols per slot with an unchanged slot duration and with no change to the frame structure above the slot. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.211 (v 8.9.0) § 6.2.3 and 3GPP TS 36.300 (v 8.12.0) § 5.1.

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5.1 Downlink Transmission Scheme

5.1.1 Basic transmission scheme based on OFDM

The downlink transmission scheme is based on conventional OFDM using a cyclic prefix. The OFDM sub-carrier spacing is Δf = 15 kHz. 12 consecutive sub-carriers during one slot correspond to one downlink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min}$ = 6 to $N_{RB\text{-}max}$ = 110.

In addition there is also a reduced sub-carrier spacing Δf_{low} = 7.5 kHz, only for MBMS-dedicated cell.

In the case of 15 kHz sub-carrier spacing there are two cyclic-prefix lengths, corresponding to seven and six OFDM symbols per slot respectively.

- Normal cyclic prefix: T_{CP} = 160×Ts (OFDM symbol #0) , T_{CP} = 144×Ts (OFDM symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e}$ = 512×Ts (OFDM symbol #0 to OFDM symbol #5)

  where T_s = 1/ (2048 × Δf)

In case of 7.5 kHz sub-carrier spacing, there is only a single cyclic prefix length $T_{CP\text{-}low}$ = 1024×Ts, corresponding to 3 OFDM symbols per slot.

In case of FDD, operation with half duplex from UE point of view is supported.

3GPP TS 36.300 (v 8.12.0) § 5.1.

Table 6.2.3-1: Physical resource blocks parameters.

Configuration		N_{sc}^{RB}	N_{symb}^{DL}
Normal cyclic prefix	$\Delta f = 15\,\text{kHz}$	12	7
Extended cyclic prefix	$\Delta f = 15\,\text{kHz}$		6
	$\Delta f = 7.5\,\text{kHz}$	24	3

3GPP TS 36.211 (v 8.9.0) § 6.2.3.

143. Thus, as described above, the Nokia LTE Accused Products infringe one or more claims of the ’814 Patent, including claim 1.

C. Nokia’s Infringement of the ’734 Apple LTE Patent.

144. By way of example, and as shown below, the Nokia LTE Accused Products infringe at least claim 1 of the ’734 Patent because they comply with the relevant portions of the LTE standard. For example, the Nokia LTE Accused Products comprise a device, with one or more antennas, configured to perform wireless communication. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.212 (v 8.8.0) § 5.3.1.1.

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Table 5.3.1.1-1: CRC mask for PBCH

Number of transmit antenna ports at eNodeB	PBCH CRC mask $< x_{ant,0}, x_{ant,1}, \ldots, x_{ant,15} >$
1	<0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0>
2	<1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1>
4	<0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1>

3GPP TS 36.212 (v 8.8.0) § 5.3.1.1.

145. The Nokia LTE Accused Products further comprise processing hardware coupled to the one or more antennas. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.212 (v 8.8.0) § 5.3.2.

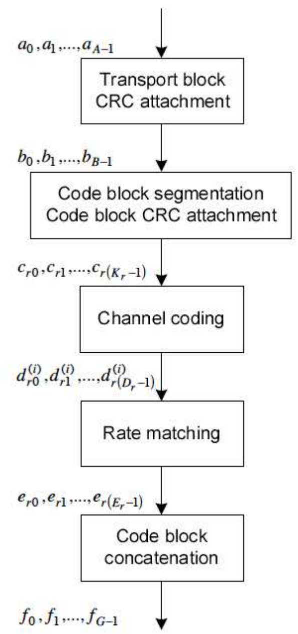

Figure 5.3.2-1: Transport channel processing for DL-SCH, PCH and MCH

3GPP TS 36.212 (v 8.8.0) § 5.3.2.

146. The Nokia LTE Accused Products further comprise processing hardware configured to encode a plurality of data bits of a data packet to produce a plurality of parity bits, wherein the plurality of data bits and the plurality of parity bits comprise an encoder packet. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.212 (v 8.8.0) §§ 5.1.3 & 5.1.3.2.

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Table 5.1.3-1: Usage of channel coding scheme and coding rate for TrCHs

TrCH	Coding scheme	Coding rate
UL-SCH	Turbo coding	1/3
DL-SCH		
PCH		
MCH		
BCH	Tail biting convolutional coding	1/3

3GPP TS 36.212 (v 8.8.0) § 5.1.3.

The output from the turbo encoder is

$$d_k^{(0)} = x_k$$

$$d_k^{(1)} = z_k$$

$$d_k^{(2)} = z'_k$$

for $k = 0,1,2,...,K-1$.

If the code block to be encoded is the 0-th code block and the number of filler bits is greater than zero, i.e., $F > 0$, then the encoder shall set $c_k = 0$, $k = 0,\ldots,(F\text{-}1)$ at its input and shall set $d_k^{(0)} = <NULL>$, $k = 0,\ldots,(F\text{-}1)$ and $d_k^{(1)} = <NULL>$, $k = 0,\ldots,(F\text{-}1)$ at its output.

The bits input to the turbo encoder are denoted by $c_0, c_1, c_2, c_3, ..., c_{K-1}$, and the bits output from the first and second 8-state constituent encoders are denoted by $z_0, z_1, z_2, z_3, ..., z_{K-1}$ and $z'_0, z'_1, z'_2, z'_3, ..., z'_{K-1}$, respectively. The bits output from the turbo code internal interleaver are denoted by $c'_0, c'_1, ..., c'_{K-1}$, and these bits are to be the input to the second 8-state constituent encoder.

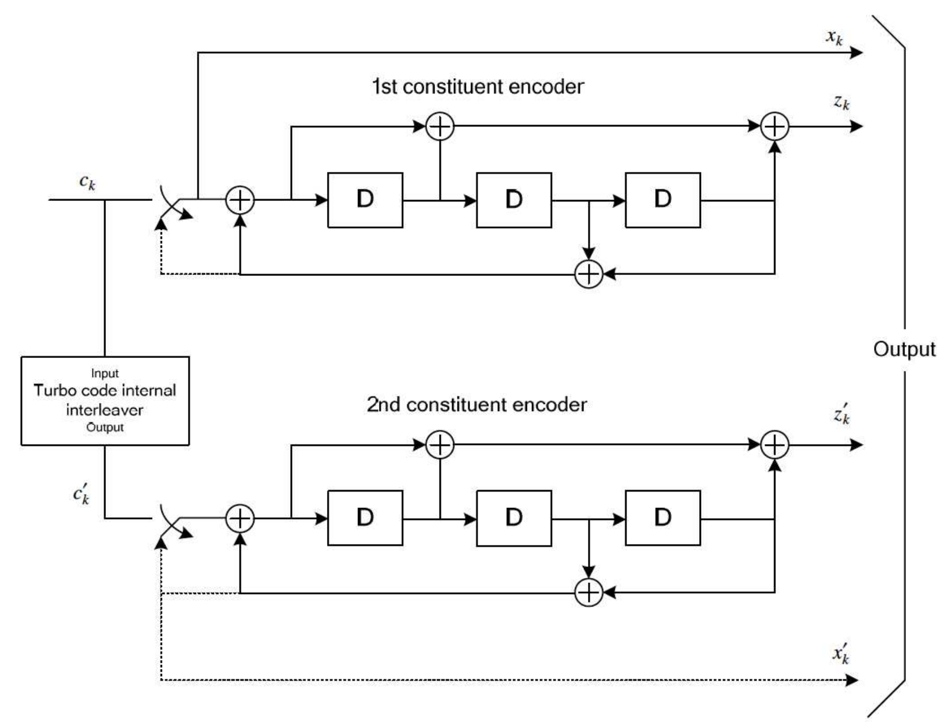

Figure 5.1.3-2: Structure of rate 1/3 turbo encoder (dotted lines apply for trellis termination only)

3GPP TS 36.212 (v 8.8.0) § 5.1.3.2.

147. The Nokia LTE Accused Products comprise processing hardware further configured to form a first sub packet from the encoder packet as a first transmission, the first sub packet including the data bits and a first set of the parity bits and the first sub packet having a first coding rate. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.212 (v 8.8.0) §§ 5.1.4.1, 5.1.4.1.2, 5.3.3, 5.3.3.1.3A, 5.3.3.1.2, 5.3.3.1.3, 5.3.3.1.4A, 5.3.3.1.5 & 5.3.3.1.5A.

5.1.4.1 Rate matching for turbo coded transport channels

The rate matching for turbo coded transport channels is defined per coded block and consists of interleaving the three information bit streams $d_k^{(0)}$, $d_k^{(1)}$ and $d_k^{(2)}$, followed by the collection of bits and the generation of a circular buffer as depicted in Figure 5.1.4-1. The output bits for each code block are transmitted as described in subclause 5.1.4.1.2.

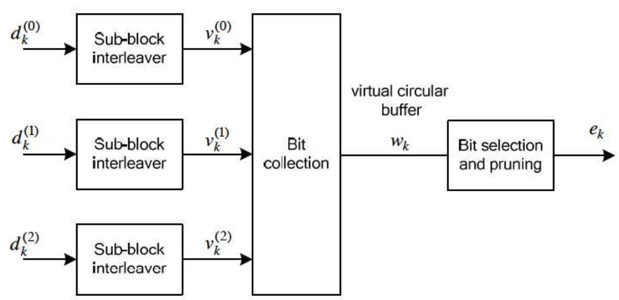

Figure 5.1.4-1. Rate matching for turbo coded transport channels

The bit stream $d_k^{(0)}$ is interleaved according to the sub-block interleaver defined in subclause 5.1.4.1.1 with an output sequence defined as $v_0^{(0)}, v_1^{(0)}, v_2^{(0)}, \ldots, v_{K_\Pi-1}^{(0)}$ and where K_Π is defined in subclause 5.1.4.1.1.

The bit stream $d_k^{(1)}$ is interleaved according to the sub-block interleaver defined in subclause 5.1.4.1.1 with an output sequence defined as $v_0^{(1)}, v_1^{(1)}, v_2^{(1)}, \ldots, v_{K_\Pi-1}^{(1)}$.

The bit stream $d_k^{(2)}$ is interleaved according to the sub-block interleaver defined in subclause 5.1.4.1.1 with an output sequence defined as $v_0^{(2)}, v_1^{(2)}, v_2^{(2)}, \ldots, v_{K_\Pi-1}^{(2)}$.

The sequence of bits e_k for transmission is generated according to subclause 5.1.4.1.2.

3GPP TS 36.212 (v 8.8.0) § 5.1.4.1.

5.1.4.1.2 Bit collection, selection and transmission

The circular buffer of length $K_w = 3K_\Pi$ for the r-th coded block is generated as follows:

$w_k = v_k^{(0)}$ for $k = 0,\ldots, K_\Pi - 1$

$w_{K_\Pi+2k} = v_k^{(1)}$ for $k = 0,\ldots, K_\Pi - 1$

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$w_{K_\Pi+2k+1} = v_k^{(2)}$ for $k = 0,\dots, K_\Pi - 1$

Denote the soft buffer size for the transport block by N_{IR} bits and the soft buffer size for the r-th code block by N_{cb} bits. The size N_{cb} is obtained as follows, where C is the number of code blocks computed in subclause 5.1.2:

- $N_{cb} = \min\left(\left\lfloor \frac{N_{IR}}{C} \right\rfloor, K_w\right)$ for downlink turbo coded transport channels
- $N_{cb} = K_w$ for uplink turbo coded transport channels

where N_{IR} is equal to:

$$N_{IR} = \left\lfloor \frac{N_{soft}}{K_{\mathrm{MIMO}} \cdot \min\left(M_{\mathrm{DL\_HARQ}}, M_{\mathrm{limit}}\right)} \right\rfloor$$

where:

N_{soft} is the total number of soft channel bits [4].

K_{MIMO} is equal to 2 if the UE is configured to receive PDSCH transmissions based on transmission modes 3 or 4 as defined in Section 7.1 in [3], 1 otherwise.

$M_{\mathrm{DL\_HARQ}}$ is the maximum number of DL HARQ processes as defined in section 7 in [3].

M_{limit} is a constant equal to 8.

Denoting by E the rate matching output sequence length for the r-th coded block, and rv_{idx} the redundancy version number for this transmission ($rv_{idx} = 0, 1, 2$ or 3), the rate matching output bit sequence is e_k, $k = 0,1,\dots, E-1$.

Define by G the total number of bits available for the transmission of one transport block.

Set $G' = G/(N_L \cdot Q_m)$ where Q_m is equal to 2 for QPSK, 4 for 16QAM and 6 for 64QAM, and where

- N_L is equal to 1 for transport blocks mapped onto one transmission layer, and
- N_L is equal to 2 for transport blocks mapped onto two or four transmission layers.

Set $\gamma = G' \bmod C$, where C is the number of code blocks computed in subclause 5.1.2.

if $r \le C - \gamma - 1$

  set $E = N_L \cdot Q_m \cdot \lfloor G'/C \rfloor$

else

  set $E = N_L \cdot Q_m \cdot \lceil G'/C \rceil$

end if

Set $k_0 = R^{TC}_{subblock} \cdot \left(2 \cdot \left\lceil \frac{N_{cb}}{8R^{TC}_{subblock}} \right\rceil \cdot rv_{idx} + 2\right)$, where $R^{TC}_{subblock}$ is the number of rows defined in subclause 5.1.4.1.1.

Set $k = 0$ and $j = 0$

while { $k < E$ }

  if $w_{(k_0+j) \bmod N_{cb}} \neq \,<NULL>$

    $e_k = w_{(k_0+j) \bmod N_{cb}}$

    $k = k + 1$

  end if

  $j = j + 1$

end while

3GPP TS 36.212 (v 8.8.0) § 5.1.4.1.2.

5.3.3 Downlink control information

A DCI transports downlink or uplink scheduling information, or uplink power control commands for one RNTI. The RNTI is implicitly encoded in the CRC.

Figure 5.3.3-1 shows the processing structure for the DCI. The following coding steps can be identified:

- Information element multiplexing
- CRC attachment
- Channel coding
- Rate matching

3GPP TS 36.212 (v 8.8.0) § 5.3.3.

5.3.3.1.3A Format 1B

DCI format 1B is used for the compact scheduling of one PDSCH codeword with precoding information.

The following information is transmitted by means of the DCI format 1B:

- Localized/Distributed VRB assignment flag – 1 bit as defined in 7.1.6.3 of [3]
- Resource block assignment – $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits as defined in 7.1.6.3 of [3]
  - For localized VRB:
    $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits provide the resource allocation
  - For distributed VRB:
    - For $N_{RB}^{DL} < 50$
      - $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits provide the resource allocation
    - For $N_{RB}^{DL} \geq 50$
      - 1 bit, the MSB indicates the gap value, where value 0 indicates $N_{gap} = N_{gap,1}$ and value 1 indicates $N_{gap} = N_{gap,2}$
      - $(\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil - 1)$ bits provide the resource allocation
- Modulation and coding scheme – 5bits as defined in section 7.1.7 of [3]
- HARQ process number – 3 bits (FDD) , 4 bits (TDD)
- New data indicator – 1 bit
- Redundancy version – 2 bits

3GPP TS 36.212 (v8.8.0) § 5.3.3.1.3A. *See also, e.g., id.* at §§ 5.3.3.1.2, 5.3.3.1.3, 5.3.3.1.4A, 5.3.3.1.5, 5.3.3.1.5A.

148. The Nokia LTE Accused Products comprise processing hardware further configured to transmit the first transmission to a receiver at a first bit rate using the one or more antennas. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.212 (v 8.8.0) §§ 5.1.4.1 & 5.1.4.1.2.

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> The sequence of bits e_k for transmission is generated according to subclause 5.1.4.1.2.

3GPP TS 36.212 (v 8.8.0) § 5.1.4.1.

> Denoting by E the rate matching output sequence length for the r-th coded block, and rv_{idx} the redundancy version number for this transmission ($rv_{idx} = 0, 1, 2$ or 3), the rate matching output bit sequence is e_k, $k = 0,1,..., E-1$.

3GPP TS 36.212 (v 8.8.0) § 5.1.4.1.2.

149. The Nokia LTE Accused Products comprise processing hardware further configured to receive a first indication from the receiver using the one or more antennas, wherein the first indication indicates that the data packet was not successfully received. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.321 (v 8.12.0) §§ 5.3.2 & 5.3.2.2, 3GPP TS 36.213 (v 8.8.0) § 7.3, and 3GPP TS 36.212 (v 8.8.0) §§ 5.2.3 & 5.2.3.1.

> ### 5.3.2 HARQ operation
>
> #### 5.3.2.1 HARQ Entity
>
> There is one HARQ entity at the UE which maintains a number of parallel HARQ processes. Each HARQ process is associated with a HARQ process identifier. The HARQ entity directs HARQ information and associated TBs received on the DL-SCH to the corresponding HARQ processes (see subclause 5.3.2.2).
>
> The number of DL HARQ processes is specified in [2], clause 7.
>
> When the physical layer is configured for spatial multiplexing [2], one or two TBs are expected per subframe and they are associated with the same HARQ process. Otherwise, one TB is expected per subframe.
>
> The UE shall:
>
> - If a downlink assignment has been indicated for this TTI:
>   - allocate the TB(s) received from the physical layer and the associated HARQ information to the HARQ process indicated by the associated HARQ information.
> - If a downlink assignment has been indicated for the broadcast HARQ process:
>   - allocate the received TB to the broadcast HARQ process.
>
> NOTE: In case of BCCH a dedicated broadcast HARQ process is used.

3GPP TS 36.321 (v 8.12.0) § 5.3.2.

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5.3.2.2 HARQ process

For each subframe where a transmission takes place for the HARQ process, one or two (in case of spatial multiplexing) TBs and the associated HARQ information are received from the HARQ entity.

For each received TB and associated HARQ information, the HARQ process shall:

- if the NDI, when provided, has been toggled compared to the value of the previous received transmission corresponding to this TB; or
- if the HARQ process is equal to the broadcast process and if this is the first received transmission for the TB according to the system information schedule indicated by RRC; or
- if this is the very first received transmission for this TB (i.e. there is no previous NDI for this TB):
  - consider this transmission to be a new transmission.
- else:
  - consider this transmission to be a retransmission.

The UE then shall:

- if this is a new transmission:
  - replace the data currently in the soft buffer for this TB with the received data.
- else if this is a retransmission:
  - if the data has not yet been successfully decoded:
    - combine the received data with the data currently in the soft buffer for this TB.
  - if the TB size is different from the last valid TB size signalled for this TB:
    - the UE may replace the data currently in the soft buffer for this TB with the received data.
- attempt to decode the data in the soft buffer for this TB;
- if the data in the soft buffer was successfully decoded for this TB:
  - if the HARQ process is equal to the broadcast process:
    - deliver the decoded MAC PDU to upper layers.
  - else if this is the first successful decoding of the data in the soft buffer for this TB:
    - deliver the decoded MAC PDU to the disassembly and demultiplexing entity.
  - generate a positive acknowledgement (ACK) of the data in this TB.
- else:
  - generate a negative acknowledgement (NACK) of the data in this TB.

3GPP TS 36.321 (v 8.12.0) § 5.3.2.2.

7.3 UE procedure for reporting ACK/NACK

For FDD, when both ACK/NACK and SR are transmitted in the same sub-frame a UE shall transmit the ACK/NACK on its assigned ACK/NACK PUCCH resource for a negative SR transmission and transmit the ACK/NACK on its assigned SR PUCCH resource for a positive SR transmission.

For TDD and all UL-DL configurations except configuration 5, two ACK/NACK feedback modes are supported by higher layer configuration.

- ACK/NACK bundling, and
- ACK/NACK multiplexing

For TDD UL-DL configuration 5, only ACK/NACK bundling is supported.

3GPP TS 36.213 (v 8.8.0) § 7.3.

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> 5.2.3 Uplink control information on PUCCH
>
> Data arrives to the coding unit in the form of indicators for measurement indication, scheduling request and HARQ acknowledgement.
>
> Three forms of channel coding are used, one for the channel quality information (CQI), another for HARQ-ACK (acknowledgement) and scheduling request and another for combination of channel quality information (CQI) and HARQ-ACK.

3GPP TS 36.212 (v 8.8.0) § 5.2.3.

> 5.2.3.1 Channel coding for UCI HARQ-ACK
>
> The HARQ acknowledgement bits are received from higher layers. HARQ-ACK consists of 1-bit of information, i.e., b_0 or 2-bits of information, i.e., b_0, b_1 with b_0 corresponding to ACK/NACK bit for codeword 0 and b_1 corresponding to that for codeword 1. Each positive acknowledgement (ACK) is encoded as a binary '1' and each negative acknowledgement (NACK) is encoded as a binary '0'. The HARQ-ACK bits are processed according to [2].

3GPP TS 36.212 (v 8.8.0) § 5.2.3.1.

150. On information and belief, the Nokia LTE Accused Products comprise processing hardware further configured to form a second sub packet from the encoder packet as a second transmission, the second sub packet including the data bits and a second set of parity bits that are different from the first set of parity bits and the second sub packet having a second coding rate that differs from the first coding rate. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.212 (v 8.8.0) §§ 5.1.4.1, 5.1.4.1.2, 5.3.3.1.3A, 5.3.3.1.2, 5.3.3.1.3, 5.3.3.1.4A, 5.3.3.1.5 & 5.3.3.1.5A.

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5.1.4.1 Rate matching for turbo coded transport channels

The rate matching for turbo coded transport channels is defined per coded block and consists of interleaving the three information bit streams $d_k^{(0)}$, $d_k^{(1)}$ and $d_k^{(2)}$, followed by the collection of bits and the generation of a circular buffer as depicted in Figure 5.1.4-1. The output bits for each code block are transmitted as described in subclause 5.1.4.1.2.

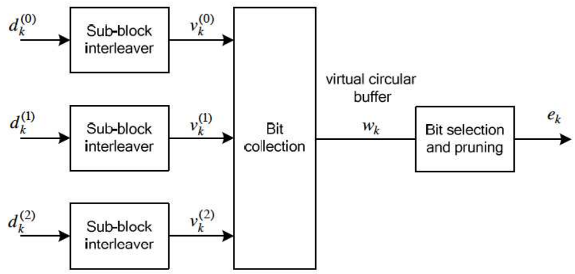

Figure 5.1.4-1. Rate matching for turbo coded transport channels

The bit stream $d_k^{(0)}$ is interleaved according to the sub-block interleaver defined in subclause 5.1.4.1.1 with an output sequence defined as $v_0^{(0)}, v_1^{(0)}, v_2^{(0)}, \ldots, v_{K_\Pi - 1}^{(0)}$ and where K_Π is defined in subclause 5.1.4.1.1.

The bit stream $d_k^{(1)}$ is interleaved according to the sub-block interleaver defined in subclause 5.1.4.1.1 with an output sequence defined as $v_0^{(1)}, v_1^{(1)}, v_2^{(1)}, \ldots, v_{K_\Pi - 1}^{(1)}$.

The bit stream $d_k^{(2)}$ is interleaved according to the sub-block interleaver defined in subclause 5.1.4.1.1 with an output sequence defined as $v_0^{(2)}, v_1^{(2)}, v_2^{(2)}, \ldots, v_{K_\Pi - 1}^{(2)}$.

The sequence of bits e_k for transmission is generated according to subclause 5.1.4.1.2.

3GPP TS 36.212 (v 8.8.0) § 5.1.4.1.

5.3.3.1.3A Format 1B

DCI format 1B is used for the compact scheduling of one PDSCH codeword with precoding information.

The following information is transmitted by means of the DCI format 1B:

- Localized/Distributed VRB assignment flag – 1 bit as defined in 7.1.6.3 of [3]
- Resource block assignment – $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits as defined in 7.1.6.3 of [3]
  - For localized VRB:

    $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits provide the resource allocation
  - For distributed VRB:
    - For $N_{RB}^{DL} < 50$
      - $\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil$ bits provide the resource allocation
    - For $N_{RB}^{DL} \geq 50$
      - 1 bit, the MSB indicates the gap value, where value 0 indicates $N_{gap} = N_{gap,1}$ and value 1 indicates $N_{gap} = N_{gap,2}$
      - $(\lceil \log_2(N_{RB}^{DL}(N_{RB}^{DL}+1)/2) \rceil - 1)$ bits provide the resource allocation
- Modulation and coding scheme – 5bits as defined in section 7.1.7 of [3]
- HARQ process number – 3 bits (FDD) , 4 bits (TDD)
- New data indicator – 1 bit
- Redundancy version – 2 bits

3GPP TS 36.212 (v 8.8.0) § 5.3.3.1.3A. *See also, e.g., id.* at §§ 5.3.3.1.2, 5.3.3.1.3, 5.3.3.1.4A, 5.3.3.1.5, 5.3.3.1.5A.

> Denoting by E the rate matching output sequence length for the r-th coded block, and rv_{idx} the redundancy version number for this transmission ($rv_{idx} = 0, 1, 2$ or 3), the rate matching output bit sequence is e_k, $k = 0,1,..., E-1$.

3GPP TS 36.212 (v 8.8.0) § 5.1.4.1.2.

151. The Nokia LTE Accused Products comprise processing hardware further configured to transmit the second transmission to the receiver at a second bit rate using the one or more antennas. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.212 (v 8.8.0) §§ 5.1.4.1 & 5.1.4.1.2.

> The sequence of bits e_k for transmission is generated according to subclause 5.1.4.1.2.

3GPP TS 36.212 (v 8.8.0) § 5.1.4.1.

> Denoting by E the rate matching output sequence length for the r-th coded block, and rv_{idx} the redundancy version number for this transmission ($rv_{idx} = 0, 1, 2$ or 3), the rate matching output bit sequence is e_k, $k = 0,1,..., E-1$.

3GPP TS 36.212 (v 8.8.0) § 5.1.4.1.2.

152. Thus, as described above, the Nokia LTE Accused Products infringe one or more claims of the ’734 Patent, including claim 1.

D. Nokia’s Infringement of the ’288 Apple LTE Patent.

153. By way of example, and as shown below, the Nokia LTE Accused Products infringe at least claim 15 of the ’288 Patent because they comply with the relevant portions of the LTE standard. For example, the Nokia LTE Accused Products comprise a base station with receive circuitry configured to receive radio frequency signals through the antennas bearing information from one or more remote transmitters. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.300 v8.12.0 § 4.1.

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The eNB hosts the following functions:

- Functions for Radio Resource Management: Radio Bearer Control, Radio Admission Control, Connection Mobility Control, Dynamic allocation of resources to UEs in both uplink and downlink (scheduling);
- IP header compression and encryption of user data stream;
- Selection of an MME at UE attachment when no routing to an MME can be determined from the information provided by the UE;
- Routing of User Plane data towards Serving Gateway;
- Scheduling and transmission of paging messages (originated from the MME);
- Scheduling and transmission of broadcast information (originated from the MME or O&M);
- Measurement and measurement reporting configuration for mobility and scheduling;
- Scheduling and transmission of ETWS messages (originated from the MME).

3GPP TS 36.300 v8.12.0 at § 4.1.

154. The Nokia LTE Accused Products further comprise a base station wherein the information from a first transmitter comprises sounding pilot information. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.211 (v 8.9.0) §§ 5.1, 5.5.1 5.5.1.3, 5.5.1.4, 5.5.3 & 5.5.3.1.

5.5 Reference signals

Two types of uplink reference signals are supported:

- Demodulation reference signal, associated with transmission of PUSCH or PUCCH
- Sounding reference signal, not associated with transmission of PUSCH or PUCCH

The same set of base sequences is used for demodulation and sounding reference signals.

5.5.1 Generation of the reference signal sequence

Reference signal sequence $r_{u,v}^{(\alpha)}(n)$ is defined by a cyclic shift α of a base sequence $\bar{r}_{u,v}(n)$ according to

$$r_{u,v}^{(\alpha)}(n) = e^{j\alpha n}\bar{r}_{u,v}(n), \quad 0 \le n < M_{sc}^{RS}$$

where $M_{sc}^{RS} = mN_{sc}^{RB}$ is the length of the reference signal sequence and $1 \le m \le N_{RB}^{max,UL}$. Multiple reference signal sequences are defined from a single base sequence through different values of α.

Base sequences $\bar{r}_{u,v}(n)$ are divided into groups, where $u \in \{0,1,...,29\}$ is the group number and v is the base sequence number within the group, such that each group contains one base sequence ($v = 0$) of each length $M_{sc}^{RS} = mN_{sc}^{RB}$, $1 \le m \le 5$ and two base sequences ($v = 0,1$) of each length $M_{sc}^{RS} = mN_{sc}^{RB}$, $6 \le m \le N_{RB}^{max,UL}$. The sequence group number u and the number v within the group may vary in time as described in Sections 5.5.1.3 and 5.5.1.4, respectively. The definition of the base sequence $\bar{r}_{u,v}(0),...,\bar{r}_{u,v}(M_{sc}^{RS}-1)$ depends on the sequence length M_{sc}^{RS}.

3GPP TS 36.211 (v 8.9.0) §§ 5.1 & 5.5.1.

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5.5.1.3 Group hopping

The sequence-group number u in slot n_s is defined by a group hopping pattern $f_{gh}(n_s)$ and a sequence-shift pattern f_{ss} according to

$$u = \left(f_{gh}(n_s) + f_{ss}\right) \bmod 30$$

There are 17 different hopping patterns and 30 different sequence-shift patterns. Sequence-group hopping can be enabled or disabled by means of the parameter *Group-hopping-enabled* provided by higher layers. PUCCH and PUSCH have the same hopping pattern but may have different sequence-shift patterns.

The group-hopping pattern $f_{gh}(n_s)$ is the same for PUSCH and PUCCH and given by

$$f_{gh}(n_s) = \begin{cases} 0 & \text{if group hopping is disabled} \\ \left(\sum_{i=0}^{7} c(8n_s + i) \cdot 2^i\right) \bmod 30 & \text{if group hopping is enabled} \end{cases}$$

where the pseudo-random sequence $c(i)$ is defined by section 7.2. The pseudo-random sequence generator shall be initialized with $c_{init} = \left\lfloor \frac{N_{ID}^{cell}}{30} \right\rfloor$ at the beginning of each radio frame.

The sequence-shift pattern f_{ss} definition differs between PUCCH and PUSCH.

For PUCCH, the sequence-shift pattern f_{ss}^{PUCCH} is given by $f_{ss}^{PUCCH} = N_{ID}^{cell} \bmod 30$.

For PUSCH, the sequence-shift pattern f_{ss}^{PUSCH} is given by $f_{ss}^{PUSCH} = \left(f_{ss}^{PUCCH} + \Delta_{ss}\right) \bmod 30$, where $\Delta_{ss} \in \{0,1,\ldots,29\}$ is configured by higher layers.

3GPP TS 36.211 (v 8.9.0) § 5.5.1.3.

5.5.1.4 Sequence hopping

Sequence hopping only applies for reference-signals of length $M_{sc}^{RS} \geq 6N_{sc}^{RB}$.

For reference-signals of length $M_{sc}^{RS} < 6N_{sc}^{RB}$, the base sequence number v within the base sequence group is given by $v = 0$.

For reference-signals of length $M_{sc}^{RS} \geq 6N_{sc}^{RB}$, the base sequence number v within the base sequence group in slot n_s is defined by

$$v = \begin{cases} c(n_s) & \text{if group hopping is disabled and sequence hopping is enabled} \\ 0 & \text{otherwise} \end{cases}$$

where the pseudo-random sequence $c(i)$ is given by section 7.2. The parameter *Sequence-hopping-enabled* provided by higher layers determines if sequence hopping is enabled or not. The pseudo-random sequence generator shall be initialized with $c_{init} = \left\lfloor \frac{N_{ID}^{cell}}{30} \right\rfloor \cdot 2^5 + f_{ss}^{PUSCH}$ at the beginning of each radio frame.

3GPP TS 36.211 (v 8.9.0) § 5.5.1.4.

5.5.3 Sounding reference signal

5.5.3.1 Sequence generation

The sounding reference signal sequence $r^{SRS}(n) = r_{u,v}^{(\alpha)}(n)$ is defined by Section 5.5.1, where u is the PUCCH sequence-group number defined in Section 5.5.1.3 and v is the base sequence number defined in Section 5.5.1.4. The cyclic shift α of the sounding reference signal is given as

$$\alpha = 2\pi \frac{n_{SRS}^{cs}}{8},$$

where n_{SRS}^{cs} is configured for each UE by higher layers and $n_{SRS}^{cs} = 0,1,2,3,4,5,6,7$.

3GPP TS 36.211 (v 8.9.0) § 5.5.3 & 5.5.3.1.

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155. The Nokia LTE Accused Products further comprise a base station wherein the sounding pilot information is mapped to at least certain subcarriers of a first group of subcarriers within a transmission time interval (TTI). As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.211 (v 8.9.0) §§ 5.5.3.2 & 5.5.3.3, 3GPP TS 36.213 (v 8.8.0) § 8.2, and 3GPP TS 36.331 (v 8.21.0) § 6.3.2 (SoundingsRS-UL-Config information element).

5.5.3.2 Mapping to physical resources

The sequence shall be multiplied with the amplitude scaling factor β_{SRS} in order to conform to the transmit power P_{SRS} specified in Section 5.1.3.1 in [4], and mapped in sequence starting with $r^{\text{SRS}}(0)$ to resource elements (k,l) according to

$$a_{2k+k_0,l} = \begin{cases} \beta_{\text{SRS}} r^{\text{SRS}}(k) & k = 0,1,\ldots,M^{\text{RS}}_{\text{sc},b}-1 \\ 0 & \text{otherwise} \end{cases}$$

where k_0 is the frequency-domain starting position of the sounding reference signal and for $b = B_{SRS}$ $M^{\text{RS}}_{\text{sc},b}$ is the length of the sounding reference signal sequence defined as

$$M^{\text{RS}}_{\text{sc},b} = m_{\text{SRS},b} N^{\text{RB}}_{\text{sc}} / 2$$

where $m_{\text{SRS},b}$ is given by Table 5.5.3.2-1 through Table 5.5.3.2-4 for each uplink bandwidth $N^{\text{UL}}_{\text{RB}}$. The cell-specific parameter *srs-BandwidthConfig* $C_{\text{SRS}} \in \{0,1,2,3,4,5,6,7\}$ and the UE-specific parameter *srs-Bandwidth* $B_{\text{SRS}} \in \{0,1,2,3\}$ are given by higher layers. For UpPTS, $m_{\text{SRS},0}$ shall be reconfigured to $m^{\max}_{\text{SRS},0} = \max_{c\in C}\{m^{c}_{SRS,0}\} \le \left(N^{\text{UL}}_{\text{RB}} - 6N_{\text{RA}}\right)$ if this reconfiguration is enabled by the cell specific parameter *srsMaxUpPts* given by higher layers, otherwise if the reconfiguration is disabled $m^{\max}_{SRS,0} = m_{SRS,0}$, where c is a SRS BW configuration and C_{SRS} is the set of SRS BW configurations from the Tables 5.5.3.2-1 to 5.5.3.2-4 for each uplink bandwidth $N^{\text{UL}}_{\text{RB}}$. N_{RA} is the number of format 4 PRACH in the addressed UpPTS and derived from Table 5.7.1-4.

The frequency-domain starting position k_0 is defined by

$$k_0 = k'_0 + \sum_{b=0}^{B_{\text{SRS}}} 2M^{\text{RS}}_{\text{sc},b} n_b$$

where for normal uplink subframes $k'_0 = \left(\lfloor N^{\text{UL}}_{\text{RB}}/2 \rfloor - m_{\text{SRS},0}/2\right) N^{\text{RB}}_{\text{SC}} + k_{\text{TC}}$, for UpPTS k'_0 is defined by:

$$k'_0 = \begin{cases} (N^{UL}_{RB} - m^{\max}_{SRS,0}) N^{RB}_{\text{sc}} + k_{TC} & \text{if } \left((n_f \bmod 2)\times(2-N_{SP}) + n_{hf}\right) \bmod 2 = 0 \\ k_{TC} & \text{otherwise} \end{cases}$$

$k_{\text{TC}} \in \{0,1\}$ is the parameter *transmissionComb* provided by higher layers for the UE, and n_b is frequency position index. n_{hf} is equal to 0 for UpPTS in first half frame, and equal to 1 for UpPTS in second half frame.

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The frequency hopping of the sounding reference signal is configured by the parameter *srs-HoppingBandwidth*, $b_{hop} \in \{0,1,2,3\}$, provided by higher layers. If frequency hopping of the sounding reference signal is not enabled (i.e., $b_{hop} \geq B_{SRS}$), the frequency position index n_b remains constant (unless re-configured) and is defined by $n_b = \lfloor 4n_{\text{RRC}}/m_{\text{SRS},b} \rfloor \bmod N_b$ where the parameter *freqDomainPosition* n_{RRC} is given by higher layers for the UE. If frequency hopping of the sounding reference signal is enabled (i.e., $b_{hop} < B_{SRS}$), the frequency position indexes n_b are defined by

$$n_b = \begin{cases} \lfloor 4n_{\text{RRC}}/m_{\text{SRS},b} \rfloor \bmod N_b & b \leq b_{hop} \\ \{F_b(n_{SRS}) + \lfloor 4n_{\text{RRC}}/m_{\text{SRS},b} \rfloor\} \bmod N_b & \text{otherwise} \end{cases}$$

where N_b is given by Table 5.5.3.2-1 through Table 5.5.3.2-4 for each uplink bandwidth $N_{\text{RB}}^{\text{UL}}$.

$$F_b(n_{SRS}) = \begin{cases} (N_b/2)\left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^{b} N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor + \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^{b} N_{b'}}{2\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor & \text{if } N_b \text{ even} \\ \lfloor N_b/2 \rfloor \lfloor n_{SRS}/\Pi_{b'=b_{hop}}^{b-1} N_{b'} \rfloor & \text{if } N_b \text{ odd} \end{cases}$$

where $N_{b_{hop}} = 1$ regardless of the N_b value on Table 5.5.3.2-1 through Table 5.5.3.2-4, and

$$n_{\text{SRS}} = \begin{cases} 2N_{SP}n_f + 2(N_{SP}-1)\left\lfloor \frac{n_s}{10} \right\rfloor + \left\lfloor \frac{T_{offset}}{T_{offset\_max}} \right\rfloor, & \text{for 2ms SRS periodicity of frame structure 2} \\ \lfloor (n_f \times 10 + \lfloor n_s/2 \rfloor)/T_{SRS} \rfloor & \text{otherwise} \end{cases}$$

counts the number of UE-specific SRS transmissions, where T_{SRS} is UE-specific periodicity of SRS transmission defined in section 8.2 of [4], T_{offset} is SRS subframe offset defined in Table 8.2-2 of [4] and T_{offset_max} is the maximum value of T_{offset} for a certain configuration of SRS subframe offset.

For all subframes other than special subframes, the sounding reference signal shall be transmitted in the last symbol of the subframe.

Table 5.5.3.2-1: $m_{\text{SRS},b}$ and N_b, $b = 0,1,2,3$, values for the uplink bandwidth of $6 \leq N_{\text{RB}}^{\text{UL}} \leq 40$.

SRS bandwidth configuration	SRS-Bandwidth $B_{\text{SRS}} = 0$		SRS-Bandwidth $B_{\text{SRS}} = 1$		SRS-Bandwidth $B_{\text{SRS}} = 2$		SRS-Bandwidth $B_{\text{SRS}} = 3$	
C_{SRS}	$m_{\text{SRS},0}$	N_0	$m_{\text{SRS},1}$	N_1	$m_{\text{SRS},2}$	N_2	$m_{\text{SRS},3}$	N_3
0	36	1	12	3	4	3	4	1
1	32	1	16	2	8	2	4	2
2	24	1	4	6	4	1	4	1
3	20	1	4	5	4	1	4	1
4	16	1	4	4	4	1	4	1
5	12	1	4	3	4	1	4	1
6	8	1	4	2	4	1	4	1
7	4	1	4	1	4	1	4	1

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Table 5.5.3.2-2: $m_{\mathrm{SRS},b}$ **and** N_b, $b=0,1,2,3$, **values for the uplink bandwidth of** $40 < N_{\mathrm{RB}}^{\mathrm{UL}} \leq 60$.

SRS bandwidth configuration	SRS-Bandwidth $B_{\mathrm{SRS}}=0$		SRS-Bandwidth $B_{\mathrm{SRS}}=1$		SRS-Bandwidth $B_{\mathrm{SRS}}=2$		SRS-Bandwidth $B_{\mathrm{SRS}}=3$	
C_{SRS}	$m_{\mathrm{SRS},0}$	N_0	$m_{\mathrm{SRS},1}$	N_1	$m_{\mathrm{SRS},2}$	N_2	$m_{\mathrm{SRS},3}$	N_3
0	48	1	24	2	12	2	4	3
1	48	1	16	3	8	2	4	2
2	40	1	20	2	4	5	4	1
3	36	1	12	3	4	3	4	1
4	32	1	16	2	8	2	4	2
5	24	1	4	6	4	1	4	1
6	20	1	4	5	4	1	4	1
7	16	1	4	4	4	1	4	1

Table 5.5.3.2-3: $m_{\mathrm{SRS},b}$ **and** N_b, $b=0,1,2,3$, **values for the uplink bandwidth of** $60 < N_{\mathrm{RB}}^{\mathrm{UL}} \leq 80$.

SRS bandwidth configuration	SRS-Bandwidth $B_{\mathrm{SRS}}=0$		SRS-Bandwidth $B_{\mathrm{SRS}}=1$		SRS-Bandwidth $B_{\mathrm{SRS}}=2$		SRS-Bandwidth $B_{\mathrm{SRS}}=3$	
C_{SRS}	$m_{\mathrm{SRS},0}$	N_0	$m_{\mathrm{SRS},1}$	N_1	$m_{\mathrm{SRS},2}$	N_2	$m_{\mathrm{SRS},3}$	N_3
0	72	1	24	3	12	2	4	3
1	64	1	32	2	16	2	4	4
2	60	1	20	3	4	5	4	1
3	48	1	24	2	12	2	4	3
4	48	1	16	3	8	2	4	2
5	40	1	20	2	4	5	4	1
6	36	1	12	3	4	3	4	1
7	32	1	16	2	8	2	4	2

Table 5.5.3.2-4: $m_{\mathrm{SRS},b}$ **and** N_b, $b=0,1,2,3$, **values for the uplink bandwidth of** $80 < N_{\mathrm{RB}}^{\mathrm{UL}} \leq 110$.

SRS bandwidth configuration	SRS-Bandwidth $B_{\mathrm{SRS}}=0$		SRS-Bandwidth $B_{\mathrm{SRS}}=1$		SRS-Bandwidth $B_{\mathrm{SRS}}=2$		SRS-Bandwidth $B_{\mathrm{SRS}}=3$	
C_{SRS}	$m_{\mathrm{SRS},0}$	N_0	$m_{\mathrm{SRS},1}$	N_1	$m_{\mathrm{SRS},2}$	N_2	$m_{\mathrm{SRS},3}$	N_3
0	96	1	48	2	24	2	4	6
1	96	1	32	3	16	2	4	4
2	80	1	40	2	20	2	4	5
3	72	1	24	3	12	2	4	3
4	64	1	32	2	16	2	4	4
5	60	1	20	3	4	5	4	1
6	48	1	24	2	12	2	4	3
7	48	1	16	3	8	2	4	2

3GPP TS 36.211 (v 8.9.0) § 5.5.3.2.

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5.5.3.3 Sounding reference signal subframe configuration

The cell specific subframe configuration period T_{SFC} and the cell specific subframe offset Δ_{SFC} for the transmissi of sounding reference signals are listed in Tables 5.5.3.3-1 and 5.5.3.3-2, for FDD and TDD, respectively. Soundin reference signal subframes are the subframes satisfying $\lfloor n_s / 2 \rfloor \bmod T_{SFC} \in \Delta_{SFC}$. For TDD, sounding reference signal is transmitted only in configured UL subframes or UpPTS.

Table 5.5.3.3-1: FDD sounding reference signal subframe configuration

srsSubframeConfiguration	Binary	Configuration Period T_{SFC} (subframes)	Transmission offset Δ_{SFC} (subframes)
0	0000	1	{0}
1	0001	2	{0}
2	0010	2	{1}
3	0011	5	{0}
4	0100	5	{1}
5	0101	5	{2}
6	0110	5	{3}
7	0111	5	{0,1}
8	1000	5	{2,3}
9	1001	10	{0}
10	1010	10	{1}
11	1011	10	{2}
12	1100	10	{3}
13	1101	10	{0,1,2,3,4,6,8}
14	1110	10	{0,1,2,3,4,5,6,8}

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15	1111	reserved	reserved

Table 5.5.3.3-2: TDD sounding reference signal subframe configuration

srsSubframeConfiguration	Binary	Configuration Period T_{SFC} (subframes)	Transmission offset Δ_{SFC} (subframes)
0	0000	5	{1}
1	0001	5	{1, 2}
2	0010	5	{1, 3}
3	0011	5	{1, 4}
4	0100	5	{1, 2, 3}
5	0101	5	{1, 2, 4}
6	0110	5	{1, 3, 4}
7	0111	5	{1, 2, 3, 4}
8	1000	10	{1, 2, 6}
9	1001	10	{1, 3, 6}
10	1010	10	{1, 6, 7}
11	1011	10	{1, 2, 6, 8}
12	1100	10	{1, 3, 6, 9}
13	1101	10	{1, 4, 6, 7}
14	1110	reserved	reserved
15	1111	reserved	reserved

3GPP TS 36.211 (v 8.9.0) § 5.5.3.3.

– *SoundingRS-UL-Config*

The IE *SoundingRS-UL-Config* is used to specify the uplink Sounding RS configuration.

***SoundingRS-UL-Config* information element**

```
-- ASN1START

SoundingRS-UL-ConfigCommon ::=      CHOICE {
    release                             NULL,
    setup                               SEQUENCE {
        srs-BandwidthConfig                 ENUMERATED {bw0, bw1, bw2, bw3, bw4, bw5, bw6, bw7},
        srs-SubframeConfig                  ENUMERATED {
                                                sc0, sc1, sc2, sc3, sc4, sc5, sc6, sc7,
                                                sc8, sc9, sc10, sc11, sc12, sc13, sc14, sc15},
        ackNackSRS-SimultaneousTransmission BOOLEAN,
        srs-MaxUpPts                        ENUMERATED {true}           OPTIONAL    -- Cond TDD
```

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```
    }
}

SoundingRS-UL-ConfigDedicated ::=   CHOICE{
    release                             NULL,
    setup                               SEQUENCE {
        srs-Bandwidth                       ENUMERATED {bw0, bw1, bw2, bw3},
        srs-HoppingBandwidth                ENUMERATED {hbw0, hbw1, hbw2, hbw3},
        freqDomainPosition                  INTEGER (0..23),
        duration                            BOOLEAN,
        srs-ConfigIndex                     INTEGER (0..1023),
        transmissionComb                    INTEGER (0..1),
        cyclicShift                         ENUMERATED {cs0, cs1, cs2, cs3, cs4, cs5, cs6, cs7}
    }
}

-- ASN1STOP
```

3GPP TS 36.331 (v 8.21.0) § 6.3.2 (SoundingsRS-UL-Config information element).

8.2 UE sounding procedure

The following Sounding Reference Symbol (SRS) parameters are UE specific semi-statically configurable by higher layers:

- Transmission comb k_{TC}, as defined in Section 5.5.3.2 of [3]
- Starting physical resource block assignment n_{RRC}, as defined in Section 5.5.3.2 of [3]
- Duration of SRS transmission: single or indefinite (until disabled), as defined in [11]
- SRS configuration index I_{SRS} for SRS periodicity and SRS subframe offset T_{offset}, as defined in Table 8.2-1 and Table 8.2-2
- SRS bandwidth B_{SRS}, as defined in Section 5.5.3.2 of [3]
- Frequency hopping bandwidth, b_{hop}, as defined in Section 5.5.3.2 of [3]
- Cyclic shift n_{SRS}^{cs}, as defined in Section 5.5.3.2 of [3]

The cell specific SRS transmission bandwidths C_{SRS} are configured by higher layers. The allowable values are given in Section 5.5.3.2 of [3].

The cell specific SRS transmission sub-frames are configured by higher layers. The allowable values are given in Section 5.5.3.3 of [3].

3GPP TS 36.213 (v 8.8.0) § 8.2.

156. The Nokia LTE Accused Products further comprise a base station wherein the transmission time interval (TTI) comprises one or more pilot symbols and a plurality of traffic symbols. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.300 (v 8.12.0) §§ 5, 5.2, 5.2.1, 5.2.2 & 5.2.4.

5 Physical Layer for E-UTRA

Downlink and uplink transmissions are organized into radio frames with 10 ms duration. Two radio frame structures are supported:

- Type 1, applicable to FDD,
- Type 2, applicable to TDD.

Frame structure Type 1 is illustrated in Figure 5.1-1. Each 10 ms radio frame is divided into ten equally sized sub-frames. Each sub-frame consists of two equally sized slots. For FDD, 10 subframes are available for downlink transmission and 10 subframes are available for uplink transmissions in each 10 ms interval. Uplink and downlink transmissions are separated in the frequency domain.

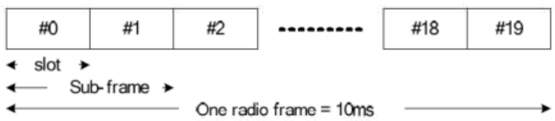

Figure 5.1-1: Frame structure type 1

Frame structure Type 2 is illustrated in Figure 5.1-2. Each 10 ms radio frame consists of two half-frames of 5 ms each. Each half-frame consists of eight slots of length 0.5 ms and three special fields: DwPTS, GP and UpPTS. The length of DwPTS and UpPTS is configurable subject to the total length of DwPTS, GP and UpPTS being equal to 1ms. Both 5ms and 10ms switch-point periodicity are supported. Subframe 1 in all configurations and subframe 6 in configuration with 5ms switch-point periodicity consist of DwPTS, GP and UpPTS. Subframe 6 in configuration with 10ms switch-point periodicity consists of DwPTS only. All other subframes consist of two equally sized slots.

For TDD, GP is reserved for downlink to uplink transition. Other Subframes/Fields are assigned for either downlink or uplink transmission. Uplink and downlink transmissions are separated in the time domain.

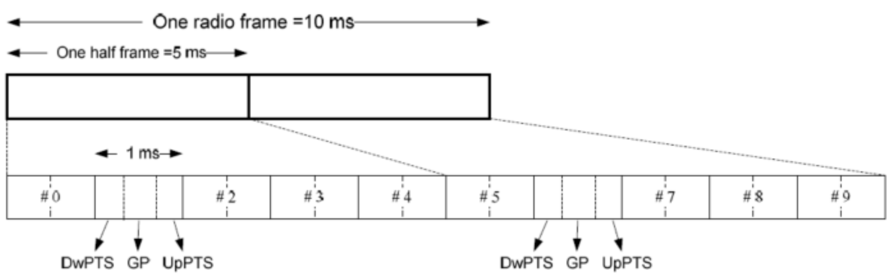

Figure 5.1-2: Frame structure type 2 (for 5ms switch-point periodicity)

Table 5.1-1: Uplink-downlink allocations.

Configuration	Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

The physical channels of E-UTRA are:

…

Physical uplink control channel (PUCCH)

- Carries Hybrid ARQ ACK/NAKs in response to downlink transmission;
- Carries Scheduling Request (SR);
- Carries CQI reports.

Physical uplink shared channel (PUSCH)

- Carries the UL-SCH.

Physical random access channel (PRACH)

- Carries the random access preamble.

3GPP TS 36.300 (v 8.12.0) § 5.

5.2 Uplink Transmission Scheme

5.2.1 Basic transmission scheme

For both FDD and TDD, the uplink transmission scheme is based on single-carrier FDMA, more specifically DFTS-OFDM.

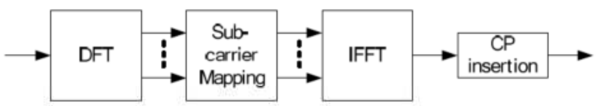

Figure 5.2.1-1: Transmitter scheme of SC-FDMA

The uplink sub-carrier spacing Δf = 15 kHz. The sub-carriers are grouped into sets of 12 consecutive sub-carriers, corresponding to the uplink resource blocks. 12 consecutive sub-carriers during one slot correspond to one uplink *resource block*. In the frequency domain, the number of resource blocks, N_{RB}, can range from $N_{RB\text{-}min} = 6$ to $N_{RB\text{-}max} = 110$.

There are two cyclic-prefix lengths defined: Normal cyclic prefix and extended cyclic prefix corresponding to seven and six SC-FDMA symbol per slot respectively.

- Normal cyclic prefix: $T_{CP} = 160 \times Ts$ (SC-FDMA symbol #0) , $T_{CP} = 144 \times Ts$ (SC-FDMA symbol #1 to #6)
- Extended cyclic prefix: $T_{CP\text{-}e} = 512 \times Ts$ (SC-FDMA symbol #0 to SC-FDMA symbol #5)

5.2.2 Physical-layer processing

The uplink physical layer processing of transport channels consists of the following steps:

- CRC insertion: 24 bit CRC is the baseline for PUSCH;
- Channel coding: turbo coding based on QPP inner interleaving with trellis termination;
- Physical-layer hybrid-ARQ processing;
- Scrambling: UE-specific scrambling;
- Modulation: QPSK, 16QAM, and 64QAM (64 QAM optional in UE);
- Mapping to assigned resources and antennas ports.

…

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5.2.4 Uplink Reference signal

Uplink reference signals [for channel estimation for coherent demodulation] are transmitted in the 4-th block of the slot [*assumed normal CP*]. The uplink reference signals sequence length equals the size (number of sub-carriers) of the assigned resource.

The uplink reference signals are based on prime-length Zadoff-chu sequences that are cyclically extended to the desired length.

Multiple reference signals can be created:

- Based on different Zadoff-Chu sequence from the same set of Zadoff-Chu sequences;
- Different shifts of the same sequence.

3GPP TS 36.300 (v 8.12.0) §§ 5.2, 5.2.1, 5.2.2 & 5.2.4.

157. The Nokia LTE Accused Products further comprise a base station wherein the one or more pilot symbols comprises at least the first group of subcarriers and at least a second group of subcarriers, wherein the first group of subcarriers are sounding pilots, wherein the second group of subcarriers are pilots for demodulation, and wherein the second group does not comprise sounding pilots. As shown below, the corresponding functionality is described in the LTE standard, including but not limited to 3GPP TS 36.211 (v 8.9.0) §§ 5.5, 5.5.1, 5.5.2.1, 5.5.2.1.1, 5.5.2.1.2, 5.5.3.1 & 5.5.3.2, 3GPP TS 36.213 (v 8.8.0) § 8.2, and 3GPP TS 36.300 (v 8.12.0) § 5.2.4.

5.5 Reference signals

Two types of uplink reference signals are supported:

- Demodulation reference signal, associated with transmission of PUSCH or PUCCH
- Sounding reference signal, not associated with transmission of PUSCH or PUCCH

The same set of base sequences is used for demodulation and sounding reference signals.

5.5.1 Generation of the reference signal sequence

Reference signal sequence $r_{u,v}^{(\alpha)}(n)$ is defined by a cyclic shift α of a base sequence $\bar{r}_{u,v}(n)$ according to

$$r_{u,v}^{(\alpha)}(n) = e^{j\alpha n}\bar{r}_{u,v}(n), \quad 0 \le n < M_{\mathrm{sc}}^{\mathrm{RS}}$$

where $M_{\mathrm{sc}}^{\mathrm{RS}} = mN_{\mathrm{sc}}^{\mathrm{RB}}$ is the length of the reference signal sequence and $1 \le m \le N_{\mathrm{RB}}^{\max,\mathrm{UL}}$. Multiple reference signal sequences are defined from a single base sequence through different values of α.

Base sequences $\bar{r}_{u,v}(n)$ are divided into groups, where $u \in \{0,1,\ldots,29\}$ is the group number and v is the base sequence number within the group, such that each group contains one base sequence ($v = 0$) of each length $M_{\mathrm{sc}}^{\mathrm{RS}} = mN_{\mathrm{sc}}^{\mathrm{RB}}$, $1 \le m \le 5$ and two base sequences ($v = 0,1$) of each length $M_{\mathrm{sc}}^{\mathrm{RS}} = mN_{\mathrm{sc}}^{\mathrm{RB}}$, $6 \le m \le N_{\mathrm{RB}}^{\max,\mathrm{UL}}$. The sequence group number u and the number v within the group may vary in time as described in Sections 5.5.1.3 and 5.5.1.4, respectively. The definition of the base sequence $\bar{r}_{u,v}(0),\ldots,\bar{r}_{u,v}(M_{\mathrm{sc}}^{\mathrm{RS}}-1)$ depends on the sequence length $M_{\mathrm{sc}}^{\mathrm{RS}}$.

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3GPP TS 36.211 (v 8.9.0) §§ 5.5 & 5.5.1.

8.2 UE sounding procedure

The following Sounding Reference Symbol (SRS) parameters are UE specific semi-statically configurable by higher layers:

- Transmission comb k_{TC}, as defined in Section 5.5.3.2 of [3]
- Starting physical resource block assignment n_{RRC}, as defined in Section 5.5.3.2 of [3]
- Duration of SRS transmission: single or indefinite (until disabled), as defined in [11]
- SRS configuration index I_{SRS} for SRS periodicity and SRS subframe offset T_{offset}, as defined in Table 8.2-1 and Table 8.2-2
- SRS bandwidth B_{SRS}, as defined in Section 5.5.3.2 of [3]
- Frequency hopping bandwidth, b_{hop}, as defined in Section 5.5.3.2 of [3]
- Cyclic shift n_{SRS}^{cs}, as defined in Section 5.5.3.2 of [3]

The cell specific SRS transmission bandwidths C_{SRS} are configured by higher layers. The allowable values are given in Section 5.5.3.2 of [3].

The cell specific SRS transmission sub-frames are configured by higher layers. The allowable values are given in Section 5.5.3.3 of [3].

3GPP TS 36.213 (v 8.8.0) § 8.2.

5.5.3.1 Sequence generation

The sounding reference signal sequence $r^{\mathrm{SRS}}(n) = r_{u,v}^{(\alpha)}(n)$ is defined by Section 5.5.1, where u is the PUCCH sequence-group number defined in Section 5.5.1.3 and v is the base sequence number defined in Section 5.5.1.4. The cyclic shift α of the sounding reference signal is given as

$$\alpha = 2\pi \frac{n_{\mathrm{SRS}}^{\mathrm{cs}}}{8},$$

where $n_{\mathrm{SRS}}^{\mathrm{cs}}$ is configured for each UE by higher layers and $n_{\mathrm{SRS}}^{\mathrm{cs}} = 0, 1, 2, 3, 4, 5, 6, 7$.

5.5.3.2 Mapping to physical resources

The sequence shall be multiplied with the amplitude scaling factor β_{SRS} in order to conform to the transmit power P_{SRS} specified in Section 5.1.3.1 in [4], and mapped in sequence starting with $r^{\mathrm{SRS}}(0)$ to resource elements (k,l) according to

$$a_{2k+k_0,l} = \begin{cases} \beta_{\mathrm{SRS}} r^{\mathrm{SRS}}(k) & k = 0,1,\ldots,M_{\mathrm{sc},b}^{\mathrm{RS}} - 1 \\ 0 & \text{otherwise} \end{cases}$$

where k_0 is the frequency-domain starting position of the sounding reference signal and for $b = B_{SRS}$ $M_{\mathrm{sc},b}^{\mathrm{RS}}$ is the length of the sounding reference signal sequence defined as

$$M_{\mathrm{sc},b}^{\mathrm{RS}} = m_{\mathrm{SRS},b} N_{\mathrm{sc}}^{\mathrm{RB}} / 2$$

where $m_{\mathrm{SRS},b}$ is given by Table 5.5.3.2-1 through Table 5.5.3.2-4 for each uplink bandwidth $N_{\mathrm{RB}}^{\mathrm{UL}}$. The cell-specific parameter *srs-BandwidthConfig* $C_{\mathrm{SRS}} \in \{0,1,2,3,4,5,6,7\}$ and the UE-specific parameter *srs-Bandwidth* $B_{\mathrm{SRS}} \in \{0,1,2,3\}$ are given by higher layers. For UpPTS, $m_{\mathrm{SRS},0}$ shall be reconfigured to $m_{SRS,0}^{\max} = \max_{c \in C}\{m_{SRS,0}^{c}\} \leq (N_{\mathrm{RB}}^{\mathrm{UL}} - 6N_{\mathrm{RA}})$ if this reconfiguration is enabled by the cell specific parameter *srsMaxUpPts* given by higher layers, otherwise if the reconfiguration is disabled $m_{SRS,0}^{\max} = m_{SRS,0}$,where c is a SRS BW configuration and C_{SRS} is the set of SRS BW configurations from the Tables 5.5.3.2-1 to 5.5.3.2-4 for each uplink bandwidth $N_{\mathrm{RB}}^{\mathrm{UL}}$. N_{RA} is the number of format 4 PRACH in the addressed UpPTS and derived from Table 5.7.1-4.

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The frequency-domain starting position k_0 is defined by

$$k_0 = k'_0 + \sum_{b=0}^{B_{\text{SRS}}} 2M_{\text{sc},b}^{\text{RS}} n_b$$

where for normal uplink subframes $k'_0 = \left(\lfloor N_{\text{RB}}^{\text{UL}}/2 \rfloor - m_{\text{SRS},0}/2\right) N_{\text{SC}}^{\text{RB}} + k_{\text{TC}}$, for UpPTS k'_0 is defined by:

$$k'_0 = \begin{cases} (N_{RB}^{UL} - m_{SRS,0}^{\max}) N_{\text{sc}}^{RB} + k_{TC} & \text{if } \left((n_f \bmod 2) \times (2 - N_{SP}) + n_{hf}\right) \bmod 2 = 0 \\ k_{TC} & \text{otherwise} \end{cases}$$

$k_{\text{TC}} \in \{0,1\}$ is the parameter *transmissionComb* provided by higher layers for the UE, and n_b is frequency position index. n_{hf} is equal to 0 for UpPTS in first half frame, and equal to 1 for UpPTS in second half frame.

The frequency hopping of the sounding reference signal is configured by the parameter *srs-HoppingBandwidth*, $b_{hop} \in \{0,1,2,3\}$, provided by higher layers. If frequency hopping of the sounding reference signal is not enabled (i.e., $b_{hop} \geq B_{SRS}$), the frequency position index n_b remains constant (unless re-configured) and is defined by $n_b = \lfloor 4n_{\text{RRC}} / m_{\text{SRS},b} \rfloor \bmod N_b$ where the parameter *freqDomainPosition* n_{RRC} is given by higher layers for the UE. If frequency hopping of the sounding reference signal is enabled (i.e., $b_{hop} < B_{SRS}$), the frequency position indexes n_b are defined by

$$n_b = \begin{cases} \lfloor 4n_{\text{RRC}} / m_{\text{SRS},b} \rfloor \bmod N_b & b \leq b_{hop} \\ \left\{F_b(n_{SRS}) + \lfloor 4n_{\text{RRC}} / m_{\text{SRS},b} \rfloor\right\} \bmod N_b & \text{otherwise} \end{cases}$$

where N_b is given by Table 5.5.3.2-1 through Table 5.5.3.2-4 for each uplink bandwidth $N_{\text{RB}}^{\text{UL}}$.

$$F_b(n_{SRS}) = \begin{cases} (N_b/2) \left\lfloor \dfrac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^{b} N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor + \left\lfloor \dfrac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^{b} N_{b'}}{2\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor & \text{if } N_b \text{ even} \\ \lfloor N_b/2 \rfloor \left\lfloor n_{SRS} / \Pi_{b'=b_{hop}}^{b-1} N_{b'} \right\rfloor & \text{if } N_b \text{ odd} \end{cases}$$

where $N_{b_{hop}} = 1$ regardless of the N_b value on Table 5.5.3.2-1 through Table 5.5.3.2-4, and

$$n_{\text{SRS}} = \begin{cases} 2N_{SP} n_f + 2(N_{SP} - 1)\left\lfloor \dfrac{n_s}{10} \right\rfloor + \left\lfloor \dfrac{T_{offset}}{T_{offset\_\max}} \right\rfloor, & \text{for 2ms SRS periodicity of frame structure 2} \\ \lfloor (n_f \times 10 + \lfloor n_s/2 \rfloor) / T_{SRS} \rfloor & \text{otherwise} \end{cases}$$

counts the number of UE-specific SRS transmissions, where T_{SRS} is UE-specific periodicity of SRS transmission defined in section 8.2 of [4]. T_{offset} is SRS subframe offset defined in Table 8.2-2 of [4] and $T_{offset\_\max}$ is the maximum value of T_{offset} for a certain configuration of SRS subframe offset.

For all subframes other than special subframes, the sounding reference signal shall be transmitted in the last symbol of the subframe.

3GPP TS 36.211 (v 8.9.0) §§ 5.5.3.1 & 5.5.3.2.

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5.5.2.1 Demodulation reference signal for PUSCH

5.5.2.1.1 Reference signal sequence

The demodulation reference signal sequence $r^{\text{PUSCH}}(\cdot)$ for PUSCH is defined by

$$r^{\text{PUSCH}}\left(m \cdot M_{\text{sc}}^{\text{RS}} + n\right) = r_{u,v}^{(\alpha)}(n)$$

where

$$m = 0,1$$
$$n = 0,\ldots,M_{\text{sc}}^{\text{RS}} - 1$$

and

$$M_{\text{sc}}^{\text{RS}} = M_{\text{sc}}^{\text{PUSCH}}$$

Section 5.5.1 defines the sequence $r_{u,v}^{(\alpha)}(0),\ldots,r_{u,v}^{(\alpha)}(M_{\text{sc}}^{\text{RS}} - 1)$.

The cyclic shift α in a slot n_s is given as $\alpha = 2\pi n_{\text{cs}}/12$ with

$$n_{\text{cs}} = \left(n_{\text{DMRS}}^{(1)} + n_{\text{DMRS}}^{(2)} + n_{\text{PRS}}(n_s)\right) \bmod 12$$

where the values of $n_{\text{DMRS}}^{(1)}$ is given by Table 5.5.2.1.1-2 according to the parameter *cyclicShift* provided by higher layers, $n_{\text{DMRS}}^{(2)}$ is given by the cyclic shift for DMRS field in most recent DCI format 0 [3] for the transport block associated with the corresponding PUSCH transmission where the values of $n_{\text{DMRS}}^{(2)}$ is given in Table 5.5.2.1.1-1.

$n_{\text{DMRS}}^{(2)}$ shall be set to zero, if there is no PDCCH with DCI format 0 for the same transport block, and

- if the initial PUSCH for the same transport block is semi-persistently scheduled, or ,
- if the initial PUSCH for the same transport block is scheduled by the random access response grant

$n_{\text{PRS}}(n_s)$ is given by

$$n_{\text{PRS}}(n_s) = \sum_{i=0}^{7} c(8N_{\text{symb}}^{\text{UL}} \cdot n_s + i) \cdot 2^i$$

where the pseudo-random sequence $c(i)$ is defined by section 7.2. The application of $c(i)$ is cell-specific. The pseudo-random sequence generator shall be initialized with $c_{\text{init}} = \left\lfloor \frac{N_{\text{ID}}^{\text{cell}}}{30} \right\rfloor \cdot 2^5 + f_{\text{ss}}^{\text{PUSCH}}$ at the beginning of each radio frame.

Table 5.5.2.1.1-1: Mapping of Cyclic Shift Field in DCI format 0 to $n_{\text{DMRS}}^{(2)}$ Values.

Cyclic Shift Field in DCI format 0 [3]	$n_{\text{DMRS}}^{(2)}$
000	0
001	6
010	3
011	4
100	2
101	8
110	10
111	9

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Table 5.5.2.1.1-2: Mapping of *cyclicShift* to $n_{\mathrm{DMRS}}^{(1)}$ Values.

cyclicShift	$n_{\mathrm{DMRS}}^{(1)}$
0	0
1	2
2	3
3	4
4	6
5	8
6	9
7	10

5.5.2.1.2 Mapping to physical resources

The sequence $r^{\mathrm{PUSCH}}(\cdot)$ shall be multiplied with the amplitude scaling factor β_{PUSCH} and mapped in sequence starting with $r^{\mathrm{PUSCH}}(0)$ to the same set of physical resource blocks used for the corresponding PUSCH transmission defined in Section 5.3.4. The mapping to resource elements (k,l), with $l=3$ for normal cyclic prefix and $l=2$ for extended cyclic prefix, in the subframe shall be in increasing order of first k, then the slot number.

3GPP TS 36.211 (v 8.9.0) §§ 5.5.2.1, 5.5.2.1.1 & 5.5.2.1.2.

5.2.4 Uplink Reference signal

Uplink reference signals [for channel estimation for coherent demodulation] are transmitted in the 4-th block of the slot [*assumed normal CP*]. The uplink reference signals sequence length equals the size (number of sub-carriers) of the assigned resource.

The uplink reference signals are based on prime-length Zadoff-chu sequences that are cyclically extended to the desired length.

Multiple reference signals can be created:

- Based on different Zadoff-Chu sequence from the same set of Zadoff-Chu sequences;
- Different shifts of the same sequence.

3GPP TS 36.300 (v 8.12.0) § 5.2.4.

158. Thus, as described above, the Nokia LTE Accused Products infringe one or more claims of the ’288 Patent, including claim 15.

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CLAIMS FOR RELIEF

FIRST COUNTERCLAIM FOR RELIEF
(Breach of Contract)

159. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-158 as if set forth fully herein.

160. As set forth above, by committing to license the declared SEPs to adopters of the H.264 standard on RAND terms, Nokia entered into contractual commitments with the ITU and its members.

161. Every party producing products that support the H.264 standard, including Apple, is an intended third-party beneficiary of Nokia's contractual commitment—specifically Nokia's commitment to grant licenses on RAND terms to all that make, use, or sell products supporting the H.264 standard.

162. Nokia breached these contracts by:

a. [redacted]; and

b. seeking to enjoin Apple products in this and other actions based on Nokia's declared H.264 SEPs, notwithstanding that Apple is and has been willing to license Nokia's declared H.264 SEPs on RAND terms.

SECOND COUNTERCLAIM FOR RELIEF
(Promissory Estoppel)

163. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-162 as if set forth fully herein.

164. Nokia made clear and definite promises to potential licensees through its commitments to ITU that it would license its declared SEPs on RAND terms.

165. The intended purpose of Nokia's promises was to induce reliance. Nokia knew or should have reasonably expected that these promises would induce sellers of products, like Apple, to develop products that support the H.264 standard.

166. Apple developed and marketed its product and services in reliance on Nokia's promises, as described above, including investing in and supplying products that support the H.264 standard.

167. Nokia is estopped from reneging on these promises to ITU, its members, and suppliers of products supporting the H.264 standard, under the doctrine of promissory estoppel.

168. Apple has been harmed as a result of its reasonable reliance on Nokia's promises. Apple has been forced to expend resources resolving this licensing dispute, including defending patent infringement claims and efforts to enjoin its products notwithstanding Apple's continuing willingness to take a license to Nokia's declared H.264 patents on RAND terms. Apple is threatened with loss of profits, loss of customers and potential customers, loss of goodwill and product image, uncertainty in business planning, and uncertainty among customers and potential customers.

169. Apple invokes the Court's equitable powers to address this cause of action. Apple requests that the Court find that Nokia's standards-related misconduct recited herein renders unenforceable Nokia's declared H.264 SEPs.

THIRD COUNTERCLAIM FOR RELIEF
(Violation of Section 2 of the Sherman Act, 15 U.S.C. § 2)

170. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-169 as if set forth fully herein.

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171. Nokia has unlawfully monopolized each of the Input Technology Markets by making knowingly false RAND commitments regarding IPR that Nokia now claims covers the standard. Nokia engaged in this misconduct with the intent to monopolize or maintain its monopoly in the relevant Input Technology Markets.

172. Had Nokia disclosed its true intent to ignore its RAND promises, the ITU, in conjunction with the other SSOs developing H.264, would have decided to standardize an alternative technology to perform the functions purportedly covered by Nokia's declared SEPs. In the alternative, ITU would have left the relevant function out of the standard, in which case suppliers of products that support the H.264 standard would have been free to choose among various alternative technologies. In addition, Nokia's false RAND commitments made after Nokia's technology was incorporated into the standard caused the ITU and other SSOs not to revise or withdraw the portion of the standard incorporating technology purportedly covered by Nokia's declared SEPs. In all events, Nokia would not have obtained monopoly power in the Input Technology Markets.

173. As a direct and proximate result of its deceit, Nokia acquired and maintained monopoly power in the Input Technology Markets.

174. As a direct and proximate result of Nokia's unlawful monopolization, Apple has suffered injury to its business and property and is threatened by the imminent loss of profits, loss of current and potential customers, and loss of goodwill and product image. Apple suffers anticompetitive injury as a purchaser in the relevant Input Technology Markets because reasonable substitutes have been excluded. Moreover, Apple has been forced to expend significant resources because of Nokia's abuse of its unlawful monopoly power.

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FOURTH COUNTERCLAIM FOR RELIEF
(Violation of California Unfair Competition Law)

175. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-174 as if set forth fully herein.

176. By the acts alleged, Nokia has engaged in unfair competition within the meaning of Cal. Bus. & Prof. Code § 17200, et seq. both through conduct that violates the antitrust laws and conducts that violates § 17200 for other reasons.

177. Nokia's conduct, as described in these counterclaims, constitutes: (a) unlawful business acts or practices in violation of the federal antitrust laws; (b) fraudulent conduct; and (c) unfair business acts or practices, including but not limited to unfair business practices threatening an incipient violation of antitrust law, violating the policy or spirit of the antitrust laws and otherwise significantly harming competition in California and elsewhere.

178. Nokia committed unlawful business acts or practices by violating Section 2 of the Sherman Act and Section 5 of the Federal Trade Commission Act.

179. The FTC has brought an action under Section 5 where, like here, a firm refuses to abide by licensing commitments made in connection with industry standard-setting activities. *See Decision and Order, In the Matter of Negotiated Data Solutions LLC*, File No. 051-0094 (Jan. 23, 2008), *available at* https://www.ftc.gov/sites/default/files/documents/cases/2008/09/080923ndsdo.pdf (accessed Feb. 28, 2017).

180. The FTC has also brought actions under Section 5 where, like here, a holder of RAND-committed patents sought to obtain an injunction against a standard implementer. *See, e.g.*, *Decision and Order, In the Matter of Motorola Mobility LLC*, File No. 121-120 (July 24, 2013), *available at*

https://www.ftc.gov/sites/default/files/documents/cases/2013/07/130724googlemotorolado.pdf (accessed Feb. 28, 2017).

181. Nokia has engaged in fraudulent conduct by failing to disclose that it did not intend to abide by its RAND commitments.

182. Nokia committed unfair business acts or practices by: (i) failing to disclose that it did not intend to abide by its RAND commitments; and (ii) suing Apple for injunctive relief, notwithstanding that Apple is and has been willing to accept a license to Nokia's declared H.264 SEPs on RAND terms.

183. As a direct, proximate, and foreseeable result of Nokia's wrongful conduct, as alleged above, competition has been injured in the Input Technology Market. Nokia's wrongful conduct also brings a significant threat of injury for downstream price, quality, and innovation competition for electronic computing devices (including smartphones and tablets), thereby causing injury to consumers in California and elsewhere. These threatened injuries include the passing on to consumers of improper non-RAND royalties demanded by Nokia and decreases in innovation and quality competition for end products that comply with the H.264 standard. Among other things, Nokia's abusive conduct threatens to dampen innovation for products that comply with the H.264 standard by eliminating manufacturers ability to invest in and bring to market innovative products with confidence that holders of claimed essential patents will not seek to enjoin their products or demand exorbitant, non-RAND licensing terms.

184. As a direct, proximate, and foreseeable result of Nokia's wrongful conduct, as alleged above, Apple suffered harm in California and elsewhere, both as a customer in the Input Technology Markets and as a supplier of downstream products. This harm includes, among other things: (i) the unavailability of a RAND license despite Nokia's assurance that it would

offer such RAND licenses; (ii) being forced to expend resources to defend claims of patent infringement; and (iii) suffering or being threatened with increased costs, lower quality or innovation for Input Technologies, loss of profits, loss of customers and potential customers, loss of goodwill and product image, uncertainty in business planning, and uncertainty among customers and potential customers.

FIFTH COUNTERCLAIM FOR RELIEF
(Infringement of U.S. Patent No. 7,548,584)

185. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-185 as if set forth fully herein.

186. Nokia infringes and/or induces infringement of the ’584 Patent.

187. The Nokia H.264 Accused Products directly infringe one or more claims of the ’584 Patent. On information and belief, Nokia makes, uses, sells, offers for sale, and/or imports, in the United States these devices and thus directly infringes the ’584 Patent.

188. Nokia indirectly infringes the ’584 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Nokia’s customers and end-users, in this District and elsewhere in the United States. For example, Nokia’s customers and end-users directly infringe through their use of the inventions claimed in the ’584 Patent. On information and belief, Nokia induces this direct infringement by providing instructions, documentation, and other information to customers and end users suggesting they use the Nokia H.264 Accused Products in an infringing manner, including technical support, marketing, product manuals, advertisements, online documentation, developer information, installation and use documentation, and API documentation. As a result of Nokia’s inducement, Nokia’s customers and end users use the Nokia H.264 Accused Products in the way Nokia intends and, as a result, directly infringe the

’584 Patent. On information and belief, Nokia has performed and continues to perform these affirmative acts with knowledge of the ’584 Patent and with the intent, or willful blindness, that the induced acts directly infringe the ’584 Patent.

189. Nokia’s infringement of the ’584 Patent has damaged and will continue to damage Apple. Apple is entitled to recover from Nokia the damage sustained by Nokia as a result of Nokia’s wrongful and infringing acts in an amount subject to proof at trial.

SIXTH COUNTERCLAIM FOR RELIEF
(Infringement of U.S. Patent No. 8,090,026)

190. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-189 as if set forth fully herein.

191. Nokia infringes and/or induces infringement of the ’026 Patent.

192. The Nokia H.264 Accused Products directly infringe one or more claims of the ’026 Patent. On information and belief, Nokia makes, uses, sells, offers for sale, and/or imports, in the United States these devices and thus directly infringes the ’026 Patent.

193. Nokia indirectly infringes the ’026 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Nokia’s customers and end-users, in this District and elsewhere in the United States. For example, Nokia’s customers and end-users directly infringe through their use of the inventions claimed in the ’026 Patent. On information and belief, Nokia induces this direct infringement by providing instructions, documentation, and other information to customers and end users suggesting they use the Nokia H.264 Accused Products in an infringing manner, including technical support, marketing, product manuals, advertisements, online documentation, developer information, installation and use documentation, and API documentation. As a result of Nokia’s inducement, Nokia’s customers and end users use the

Nokia H.264 Accused Products in the way Nokia intends and, as a result, directly infringe the ’026 Patent. On information and belief, Nokia has performed and continues to perform these affirmative acts with knowledge of the ’026 Patent and with the intent, or willful blindness, that the induced acts directly infringe the ’026 Patent.

194. Nokia’s infringement of the ’026 Patent has damaged and will continue to damage Apple. Apple is entitled to recover from Nokia the damage sustained by Nokia as a result of Nokia’s wrongful and infringing acts in an amount subject to proof at trial.

SEVENTH COUNTERCLAIM FOR RELIEF
(Infringement of U.S. Patent No. 8,630,339)

195. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-195 as if set forth fully herein.

196. Nokia infringes and/or induces infringement of the ’339 Patent.

197. The Nokia H.264 Accused Products directly infringe one or more claims of the ’339 Patent. On information and belief, Nokia makes, uses, sells, offers for sale, and/or imports, in the United States these devices and thus directly infringes the ’339 Patent.

198. Nokia indirectly infringes the ’339 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Nokia’s customers and end-users, in this District and elsewhere in the United States. For example, Nokia’s customers and end-users directly infringe through their use of the inventions claimed in the ’339 Patent. On information and belief, Nokia induces this direct infringement by providing instructions, documentation, and other information to customers and end users suggesting they use the Nokia H.264 Accused Products in an infringing manner, including technical support, marketing, product manuals, advertisements, online documentation, developer information, installation and use documentation, and API

documentation. As a result of Nokia's inducement, Nokia's customers and end users use the Nokia H.264 Accused Products in the way Nokia intends and, as a result, directly infringe the '339 Patent. On information and belief, Nokia has performed and continues to perform these affirmative acts with knowledge of the '339 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '339 Patent.

199. Nokia's infringement of the '339 Patent has damaged and will continue to damage Apple. Apple is entitled to recover from Nokia the damage sustained by Nokia as a result of Nokia's wrongful and infringing acts in an amount subject to proof at trial.

EIGHTH COUNTERCLAIM FOR RELIEF
(Infringement of U.S. Patent No. 8,737,484)

200. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-199 as if set forth fully herein.

201. Nokia infringes and/or induces infringement of the '484 Patent.

202. The Nokia H.264 Accused Products directly infringe one or more claims of the '484 Patent. On information and belief, Nokia makes, uses, sells, offers for sale, and/or imports, in the United States these devices and thus directly infringes the '484 Patent.

203. Nokia indirectly infringes the '484 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Nokia's customers and end-users, in this District and elsewhere in the United States. For example, Nokia's customers and end-users directly infringe through their use of the inventions claimed in the '484 Patent. On information and belief, Nokia induces this direct infringement by providing instructions, documentation, and other information to customers and end users suggesting they use the Nokia H.264 Accused Products in an infringing manner, including technical support, marketing, product manuals, advertisements,

online documentation, developer information, installation and use documentation, and API documentation. As a result of Nokia's inducement, Nokia's customers and end users use the Nokia H.264 Accused Products in the way Nokia intends and, as a result, directly infringe the '484 Patent. On information and belief, Nokia has performed and continues to perform these affirmative acts with knowledge of the '484 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '484 Patent.

204. Nokia's infringement of the '484 Patent has damaged and will continue to damage Apple. Apple is entitled to recover from Nokia the damage sustained by Nokia as a result of Nokia's wrongful and infringing acts in an amount subject to proof at trial.

NINTH COUNTERCLAIM FOR RELIEF
(Infringement of U.S. Patent No. 7,551,546)

205. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-204 as if set forth fully herein.

206. Nokia infringes and/or induces infringement of the'546 Patent.

207. The Nokia LTE Accused Products directly infringe one or more claims of the '546 Patent. On information and belief, Nokia makes, uses, sells, offers for sale, and/or imports, in the United States these devices and thus directly infringes the '546 Patent.

208. Nokia indirectly infringes the '546 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Nokia's customers and end-users, in this District and elsewhere in the United States. For example, Nokia's customers and end-users directly infringe through their use of the inventions claimed in the '546 Patent. On information and belief, Nokia induces this direct infringement by providing instructions, documentation, and other information to customers and end users suggesting they use the Nokia LTE Accused Products in an

infringing manner, including technical support, marketing, product manuals, advertisements, online documentation, and installation and use documentation. As a result of Nokia's inducement, Nokia's customers and end users use the Nokia LTE Accused Products in the way Nokia intends and, as a result, directly infringe the '546 Patent. On information and belief, Nokia has performed and continues to perform these affirmative acts with knowledge of the '546 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '546 Patent.

209. Nokia's infringement of the '546 Patent has damaged and will continue to damage Apple. Apple is entitled to recover from Nokia the damage sustained by Nokia as a result of Nokia's wrongful and infringing acts in an amount subject to proof at trial.

TENTH COUNTERCLAIM FOR RELIEF
(Infringement of U.S. Patent No. 8,085,814)

210. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-209 as if set forth fully herein.

211. Nokia infringes and/or induces infringement of the'814 Patent.

212. The Nokia LTE Accused Products directly infringe one or more claims of the '814 Patent. On information and belief, Nokia makes, uses, sells, offers for sale, and/or imports, in the United States these devices and thus directly infringes the '814 Patent.

213. Nokia indirectly infringes the '814 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Nokia's customers and end-users, in this District and elsewhere in the United States. For example, Nokia's customers and end-users directly infringe through their use of the inventions claimed in the '814 Patent. On information and belief, Nokia induces this direct infringement by providing instructions, documentation, and other information

to customers and end users suggesting they use the Nokia LTE Accused Products in an infringing manner, including technical support, marketing, product manuals, advertisements, online documentation, and installation and use documentation. As a result of Nokia's inducement, Nokia's customers and end users use the Nokia LTE Accused Products in the way Nokia intends and, as a result, directly infringe the '814 Patent. On information and belief, Nokia has performed and continues to perform these affirmative acts with knowledge of the '814 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '814 Patent.

214. Nokia's infringement of the '814 Patent has damaged and will continue to damage Apple. Apple is entitled to recover from Nokia the damage sustained by Nokia as a result of Nokia's wrongful and infringing acts in an amount subject to proof at trial.

ELEVENTH COUNTERCLAIM FOR RELIEF
(Infringement of U.S. Patent No. 8,976,734)

215. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-214 as if set forth fully herein.

216. Nokia infringes and/or induces infringement of the'734 Patent.

217. The Nokia LTE Accused Products directly infringe one or more claims of the '734 Patent. On information and belief, Nokia makes, uses, sells, offers for sale, and/or imports, in the United States these devices and thus directly infringes the '734 Patent.

218. Nokia indirectly infringes the '734 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Nokia's customers and end-users, in this District and elsewhere in the United States. For example, Nokia's customers and end-users directly infringe through their use of the inventions claimed in the '734 Patent. On information and belief, Nokia

induces this direct infringement by providing instructions, documentation, and other information to customers and end users suggesting they use the Nokia LTE Accused Products in an infringing manner, including technical support, marketing, product manuals, advertisements, online documentation, and installation and use documentation. As a result of Nokia's inducement, Nokia's customers and end users use the Nokia LTE Accused Products in the way Nokia intends and, as a result, directly infringe the '734 Patent. On information and belief, Nokia has performed and continues to perform these affirmative acts with knowledge of the '734 Patent and with the intent, or willful blindness, that the induced acts directly infringe the '734 Patent.

219. Nokia's infringement of the '734 Patent has damaged and will continue to damage Apple. Apple is entitled to recover from Nokia the damage sustained by Nokia as a result of Nokia's wrongful and infringing acts in an amount subject to proof at trial.

TWELFTH COUNTERCLAIM FOR RELIEF
(Infringement of U.S. Patent No. 9,106,288)

220. Apple repeats and realleges the allegations of the preceding Counterclaim Paragraphs 1-219 as if set forth fully herein.

221. Nokia infringes and/or induces infringement of the'288 Patent.

222. The Nokia LTE Accused Products directly infringe one or more claims of the '288 Patent. On information and belief, Nokia makes, uses, sells, offers for sale, and/or imports, in the United States these devices and thus directly infringes the '288 Patent.

223. Nokia indirectly infringes the '288 Patent, as provided in 35 U.S.C. § 271(b), by inducing infringement by others, such as Nokia's customers and end-users, in this District and elsewhere in the United States. For example, Nokia's customers and end-users directly infringe

through their use of the inventions claimed in the ’288 Patent. On information and belief, Nokia induces this direct infringement by providing instructions, documentation, and other information to customers and end users suggesting they use the Nokia LTE Accused Products in an infringing manner, including technical support, marketing, product manuals, advertisements, online documentation, and installation and use documentation. As a result of Nokia’s inducement, Nokia’s customers and end users use the Nokia LTE Accused Products in the way Nokia intends and, as a result, directly infringe the ’288 Patent. On information and belief, Nokia has performed and continues to perform these affirmative acts with knowledge of the ’288 Patent and with the intent, or willful blindness, that the induced acts directly infringe the ’288 Patent.

224. Nokia’s infringement of the ’288 Patent has damaged and will continue to damage Apple. Apple is entitled to recover from Nokia the damage sustained by Nokia as a result of Nokia’s wrongful and infringing acts in an amount subject to proof at trial.

DEMAND FOR JURY TRIAL

Apple hereby demands a trial by jury on all issues so triable raised by Plaintiffs’ Complaint or by Apple’s Answer, Defenses, and Counterclaims.

PRAYER FOR RELIEF

WHEREFORE, Apple requests that the Court enter Judgment in favor and against Plaintiffs as follows:

a) Dismiss Plaintiffs’ Complaint in its entirety, with prejudice;

b) Enter judgment in favor of Apple and against Plaintiffs;

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c) Adjudge and decree that Nokia is liable for breach of contract, promissory estoppel, violation of Section 2 of the Sherman Act, 15 U.S.C. § 2, and/or violation of Cal. Bus. & Prof. Code § 17200;

d) Declare that, to the extent any of the alleged inventions described in and allegedly covered by Nokia's patents are used, manufactured, or sold by or for Apple, its suppliers, and/or its customers due to encoding or decoding of H.264 content, Apple has the irrevocable right to be licensed on RAND terms under those patents;

e) Award Apple damages that it proves at trial;

f) On Apple's Third Counterclaim for relief, pursuant to Section 4 of the Clayton Act, 15 U.S.C. § 15, enter judgment against Nokia for treble the amount of Apple's damages;

g) Enjoin Nokia from demanding from Apple non-RAND terms for patents that are essential or declared essential to H.264, from seeking injunctions on such patents, and from committing further breaches of its RAND promises or other unfair or unlawful acts;

h) Declare that Nokia's declared essential patents are unenforceable against Apple;

i) Declare that each of the Nokia asserted patents in this action are unenforceable against Apple;

j) Enter judgment that Nokia infringes the Apple asserted patents in this action;

k) Award Apple damages in an amount sufficient to compensate Apple for Nokia's infringement of the Apple asserted patents in this action;

l) Award Apple pre-judgment and post-judgment interest to the full extent allowed under the law;

m) Order Nokia to provide an accounting of damages for acts of infringement;

n) Award Apple its costs, attorneys' fees and expenses incurred in this action; and

o) Grant such further relief as the Court deems just and proper.

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Dated: March 20, 2017.

Respectfully submitted,

/s/ *Clayton C. James*

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CERTIFICATE OF SERVICE

I hereby certify that on March 20, 2017, I electronically filed a true and correct copy of the foregoing document using the Court's CM/ECF system, which will serve electronic notification of this filing to all counsel of record.

/s/ Clayton C. James
Clayton C. James